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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XXII.—NO. 543

THE GOVERNMENT AND THE TELEPHONE COMPANIES.

ON Friday, the 13th inst., a deputation representing the Association of Chambers of Commerce waited upon the Postmaster-General in reference to telephonic and telegraphic charges, Colonial postage, and telegraphic money orders.

The interview, although resulting in no very definite promises, can hardly be considered unproductive, inasmuch as it has at least been successful in eliciting some expression of the views of the Postal Department with respect to telephonic enterprise, and the transmission of money orders by telegraph. With satisfaction we look forward to the promised reduction in postage to the Australian Colonies; and we hope that it will prove a presage of that which is to follow in relation to the postal rates with India and China. Intercommunication between England and her Colonies is now so general that a ready and economical postage is becoming indispensable. Although these reductions are not an established fact so far, yet there can be little doubt of their taking place at no distant date, and we are happy in availing ourselves of the opportunity to express our gratification at the success which would appear to have attended the efforts of the Postmaster-General to thus meet the wishes of the general public.

With regard to the telephone question it will be remembered that some short time since a deputation waited upon Mr. Raikes at Wolverhampton, and amongst other questions raised that of telephone charges. Mr. Raikes avails himself of the opportunity afforded by the addresses presented to him on the present occasion to explain that his remarks at Wolverhampton were not entitled to be construed into an intention of the Government to acquire the telephone companies. He however, admits that if a universal system is to be employed, it is plain that it must be either in the hands of one universal company, or it must be in the hands of the Government. He does not imagine the Government would be asked to give a monopoly of telephones to any particular company, and this being so it may be assumed that the desire would tend towards the acquisition of the telephones entirely by the Government.

From this we in no way dissent. On the contrary, we are quite in accord with Mr. Raikes, that it is not desirable the telephone service of the country should be in the hands of several independent companies—that it should not be in the hands of even one company, but in those of the department created for the special purpose of conducting, in the interests of the common weal, the telegraphic service of the country. We thank the Postmaster-General for his condemnation of a system which can scarcely be regarded as desirable, and which we now hope to see modified in such a manner as will bring it more thoroughly in unison with the requirements of the community at large. A glance at the map recently issued by the National Telephone Company will readily show to what extent telephone enterprise aspires. From it we may learn that at no distant date telephonic communication will be complete between all large centres of commerce from one end of the country to the other. In no sense do we blame the National, or any other telephone company, for their enterprise; on the contrary, they are worthy of all commendation. Very little time have they lost since was accorded to them the right to establish and carry on telephonic correspondence between city and city. That to which we point is the fact—incontrovertible—that the telephone system is rapidly developing into a telegraphic system, subject, it is true, to certain tribute to the State telegraph department, but otherwise competitive with it. The Postmaster-General condemns the arrangement under which such a service is conducted by several independent, or semi-independent companies. He condemns such a system conducted by any one company to whom exclusive rights might be given. There is but one other course open, and that the course which he assumed the wishes of the deputation which waited upon him tended towards, viz., the acquisition of the telephones by the Government.

But what says Mr. Raikes on this? That this is not the most favourable moment for taking up the question with a view to action. The patents of the companies give them something like a practical monopoly, but there will come a time when the Government will be able to treat with them on better terms than at present. He readily admitted that the telephonic system had been cramped by the conditions under which it existed, and he should be glad if any change could be made which would be satisfactory to the public. Such is reported to be the sum and substance of the Postmaster-General's remarks. The existing system is acknowledged to be unsatisfactory, and he would be glad if any change could be accomplished which would place it upon a more desirable footing. Surely if this is the view entertained by the chief of the Department responsible for the conduct of the country's telegraphic correspondence, it is time it were mended. Is it quite compatible with the dignity of a State department, or fair towards those whose interests are to be affected, that the country should be asked to put up with that which is acknowledged to be wrong, and which it is thus clearly the intention of the Government to acquire at no distant date, for another three or four years in order that the master patents under which the system is worked may have lapsed by effluxion of time? We scarcely think so: nor do we think that such a course would in the end prove remunerative to the country. Clearly it is the policy of the companies to proceed as speedily as possible with the establishment of their trunk lines. The public seek it, and the companies are laying themselves out for it. Within the period named a very large portion of their several systems will be completed. Does the Government think they will buy these lines at less than their cost? It is true that the business of the companies being somewhat new, returns may for a time prove low, but any arbitrary purchase which may take place will certainly make allowance for this should such be the case. Let us assume that the period has elapsed. What is the position? Why that numerous lines have been established and acquired by the Department, all of which have to be maintained; whereas were the system in the hands of the Government at the present moment, to the greatest possible extent, those lines would be incorporated with the State lines. If it is the intention of the Government to acquire the telephones economy will not attend the further deferment of the question, and a plain straightforward announcement to that effect would be far more satisfactory than suggestions that at a certain distant date their acquirement may be accomplished for less money. With the patents of the companies the Government can have very little to do, but whatever their worth it is only that for the period which they have to run, and that, so far as telephonic correspondence is concerned, only so far as it may affect Exchange working. Private wire arrangements would of course fall into the private wire branch and be dealt with and paid for as at present.

We are glad to see that at last the Department is inclined to give the telegraphic money order system a trial. With the old telegraph companies such conveniences were not wanting: that which a commercial undertaking was capable of conducting ought certainly to be within the reach of a Government department.

A FRIEND has suggested that one of the rules of the Society of Telegraph Engineers and Electricians, which we published in our last issue, must have been sent from the Emerald Isle. "When conductors are carried in very inflammable structures, precautions should be taken to isolate them therefrom."

WE had expected to see a better report of the Electrical Power Storage Company's business for the year ending 31st December 1887. We believe however that the current year will show a very extensive increase in the sale of secondary batteries, more especially if Mr. Crompton can prove his case in the question of accumulators *v.* transformers.

MR. SUMPNER'S suggestions for improving lightning rods will doubtless attract some attention in scientific circles. The observation that the time taken to discharge a condenser through a given resistance may be decreased by adding self-induction to the circuit may account for the remarkable results shown by Dr. Oliver Lodge in his experiments on iron and copper as lightning conductors.

WE learn that the ss. *Roddam* has been delayed in the completion of the work undertaken by the French Syndicate, owing to some hitch with regard to the obtaining permission to land the section from St. Nicolas, Hayti, at Santiago de Cuba. This delay is very unfortunate, since, considering the work, the ship has been away a long time already. We understand that the cable end at Puerto Plata on the north side of the Island Hayti-Santo Domingo, is to be connected with the cable (from Curaçao) on the south side of that Island by means of a land line. We do not pretend to much acquaintance with the interior of the Island, but from what we have read, and from what we have been told as to the difficulties of transport, absence of communications, tropical storms, luxuriant vegetation, and the many other obstacles to the proper maintenance of a line in such a wild and sparsely inhabited country, we cannot but think that the local manager will have all his work cut out to provide even a fairly efficient service.

The last number of *La Lumière Electrique* contains an article by M. A. Palaz on the electric lighting of railway stations. He cites as an example the sorting station at Porte-Simplon on the Milan-Alexandria railway, and situated some six kilometres to the westward of the central station at Milan. It was found that lights on masts would require to be placed at a very great height in order to avoid the casting of shadows by the trucks. Projectors, concentrating the light from powerful arc lights, were finally adopted, and these have given every satisfaction.

A FRIEND has just informed us by letter that in a copy of the ELECTRICAL REVIEW which had been obtained last week by his brother, there was enclosed a pamphlet descriptive of a most wonderful discovery, which is no other than Dr. Richardson's magneto-galvanic battery. Our opinion on certain forms of worse than useless electric appliances has been pretty freely expressed in the REVIEW at intervals during the past six months, and we shall esteem it a great favour if other of our readers who may have received similar enclosures, will notify us to that effect, in order that we may, if possible, trace the source from which they originate. We need scarcely say that we are powerless to prevent the insertion of loose advertisement matter in copies of the Journal when supplied through newsagents.

AN answer to the query which we put last week as to the competency of members of Town Councils and other similar bodies to take part in discussions upon subjects affecting their pecuniary interests will be found in the reports which appear in our other columns of recent meetings of the Town Councils of Bath and Taunton. The law is clearly against the practice, and as an elementary principle it would seem to be just that the private interests of individuals should not be permitted to affect the wider interests of the community in which they have temporarily unusual power and influence; at the same time a too strict reading of the law is capable of producing, as it has, in fact, produced at Bath, the farcical position in which a considerable proportion of a Town Council may find itself unable to procure a hearing upon very important subjects. It must be remembered, too, that this clause is equally operative against all forms of private interest, and it is conceivable that a time may come when the present supporters of the electric light will wish they had not been quite so determined to shut the mouths of some of their opponents by insisting upon a strict and literal reading of the Act on this matter.

THE report of the investigation committee of the Pilsen Company, which appears in our City columns, is a revelation in the matter of company management. We have no desire to commit ourselves to strong opinions upon the subject, the more especially as we have yet to hear the other side; but if there be any ground at all for the statements of Mr. Fyfe's committee there would seem to have been a deplorable amount of heedless drifting on the part of directors and officials alike.

FIRE TELEGRAPHY AND FALSE ALARMS.

A PAPER on the above subject was read by Mr. R. von Fischer-Treuenfeld at the meeting of the Society of Telegraph Engineers and Electricians on the 8th March last, and a mass of statistics, all taken from the official reports of the chiefs of the various fire brigades, was given. A sketch was thus drawn of the present state of fire telegraphy in various towns and countries, and the writer of the paper was afforded the great satisfaction of hearing, during the discussion which followed, some of the highest authorities in such matters acknowledge the correctness of the conclusions at which he had arrived, which view was endorsed by various technical journals.

There is, however, one point upon which a misleading conclusion has been drawn, and that has reference to the important and, at the same time, surprising information which the gallant chief officer of the Metropolitan Fire Brigade gave during the discussion as to the great number of "false alarms" which are still received by the brigade from the electrical street call posts. Captain Shaw admitted that the introduction of call-points in the streets of London had been attended with very beneficial results. He said that during last year, out of a total of 2,363 calls received at fire stations, 1,195 calls came through the electrical call apparatus; 170 of those were, however, distinctly traced to a mischievous origin, 74 were due to unknown causes, 91 to the lines being out of order, 14 to collisions of vehicles with the alarm posts, and 13 were caused by men who were working on the lines ringing the bells by accident. There were thus during last year in London 362 false and 833 good electrical calls transmitted from the street call posts.

In the paper under review, the hope was expressed "that long since the men of the Metropolitan Fire Brigade, so unusually overtaxed with labour, have had no serious complaint to make of being needlessly harrasssed by maliciously raised alarms;" but according to Captain Shaw's recent figures, which caused as much surprise to the author of the paper as to the meeting, this expectation has not been realised in London. The subject therefore certainly requires some further investigation, the more so as this unfortunate experience is sure to become a serious obstacle to the development of fire telegraphy in England, if it be not at once shown that it is decidedly the exception and not the rule.

If the official reports and fire statistics of other countries be investigated it is found that, taken generally, only a few false alarms are received; nothing to compare with the number mentioned by Captain Shaw in reference to the London fires. This fact, combined with the wording of the 1881 report of the chief officer of the Metropolitan Fire Brigade, viz.:—"We still continue to be harassed by occasional false alarms" . . . . . and: "I have every hope that each succeeding year will be characterised by even a greater advance in the value of these most useful aids to our efficiency . . . . ." led to the erroneous conclusion that the London fire telegraphs had already reached that state of efficiency and reliability to which other towns, after going through similar experiences during the first few years of the existence of the fire alarm apparatus, had succeeded in attaining.

Captain Shaw, however, has thrown quite a different light on the question of "false alarms in London," on their origin, and on the difficulties caused by them to the men of the brigade under his command; but in order to fully understand, and if possible to find a remedy for this evil, it is necessary to analyse Captain Shaw's figures, and to compare them with figures of a similar class received from another city, for instance from the city of Berlin.

Table I. shows the number of false and good alarms given during the year 1887 in London and in Berlin, and the difference between the results obtained by the fire telegraphs in these two towns is most marked. The Berlin fire telegraphs, which were first installed in the year 1849 by Messrs. Siemens and Halske, who afterwards, in the year of 1853, erected the first electrical fire-alarm posts, and which have given continuous proofs of their efficiency, show the remarkably low figure of only 14 "false calls" during the entire year, as compared with 362 false calls in London. In other words, expressed in the percentage of false to good calls, these figures show that London received from the street call posts about 30 per cent., whereas Berlin only received about 4 per cent. of false calls.

In Table II. the two classes of false alarms are compared—viz., such alarms as are sent maliciously and such as are inherent to the type of fire alarm circuit in use. The question has, therefore, so to speak, a social and a technical side. The social question embraces the number of false alarms sent maliciously, which alarms amount to 14·2 per cent. in London, but only to 3·5 in Berlin; or, to bring the malicious calls home to the inhabitants, there are about 4 false alarms to each

TABLE I.

Fire Alarms received from Street Call Posts.

Town.	Year.	Sent maliciously.	Due to unknown causes.	Due to lines being out of order.	Due to collisions of vehicles with alarm posts.	Due to accidental ringing during repairs of the line.	Due to insignificant fires.	Total number of fire alarm calls sent from street call posts.			Percentage of false and good calls sent from street call posts.		
								False calls.	Good calls.	Total calls.	False calls.	Good calls.	Total.
London.........	1887	170	74	91	14	13	13*	362	833	1,195	30·3	69·7	100
Berlin	1887	14	...	...	...	...	...	14	383	397	3·5	96·5	100

* Not to be counted as false calls.

TABLE II.

Fire Alarms received from Street Call Posts.

Town.	Year.	False calls sent maliciously.	False calls due to defects in the electric alarm system.	Good calls.	Total.	Percentage of false and good fire alarm calls sent from street call posts.				Number of false calls sent maliciously compared with the number of inhabitants.	
						False calls sent maliciously.	False calls due to defects in the system.	Good calls.	Total.	Inhabitants.	Malicious calls per 100,000 inhabitants.
London.........	1887	170	192	833	1,195	14·2	16·1	69·7	100	4,149,000	4·09
Berlin	1887	14	None	383	397	3·5	None	96 5	100	1,362,384	1·05

100,000 inhabitants in London, whereas the proportion in Berlin is only 1 to each 100,000 inhabitants.

With regard to the technical question it is found that the Siemens fire-telegraph in Berlin has not been the cause of a single false alarm, inherent to the system, during the year 1887, whilst Captain Shaw's figures show that 192 false calls were due to defects in the London fire-telegraph systems.

The proportionate number of street call posts being much greater in Berlin than in London, the former city having 1 street apparatus to each 5,538 inhabitants, whilst the latter has only 1 to 119,594 inhabitants, it follows that under the same conditions the danger of false alarms should be greater in Berlin than in London, but it is found, in result, that the contrary is the case.

The correctness of the figures upon which these two tables are based, coming as they do from the two highest authorities on the subject, viz., the chief officer of the London Metropolitan and the chief officer of the Royal Berlin Fire Brigades, is undeniable. The tables have a double significance; the one shows that the false alarms due to maliciousness are far too many in London, whilst the other shows that false alarms due to defects in the electrical system could be entirely eliminated by the adoption of a telegraph system which is intrinsically free from the defects which operate in causing the class of false alarms enumerated by Captain Shaw.

With regard to these defects, the chief officer of the Royal Berlin Fire Brigade, Major Strude, by whose kindness these figures have been obtained, made the following remarks: "During the last year there were no false alarms caused by carelessness during repairs and inspections of the lines and electrical apparatus. As the 'Siemens' street call posts transmit a certain sign six times consecutively, which sign is recorded by a Morse apparatus at the fire station, electrically connected with the street call posts, a false alarm during repairs, or through contact in the line, cannot well take place. Our fire telegraph lines are, besides nearly all underground, so that it is a rare case for them to get damaged . . . . ."

It will thus be seen, by a comparison between the results obtained in London and those in Berlin, that the technical question of false alarms can be satisfactorily solved, and, if further proofs were necessary, it would be easy to bring similar comparisons with any other of the 40 or 50 towns supplied with the Siemens fire telegraph system.

With regard to the social question of false alarms, and the best means to be adopted to reduce the present high rate in London of 14 per cent. to a more reasonable figure, nothing better can be suggested than to follow the advice of the most competent person on this subject in the country, Captain Shaw himself, who already, in his yearly reports of 1880 and 1881, has recommended that severe punishment be inflicted on "those evil-disposed persons who impose upon the brigade by their tricks, and have not enough intelligence to appreciate the gravity of the offence . . . . ." "The magistrates seem determined to punish most severely anyone detected in doing damage to them" (the call posts) "and the vigilance of the police is beyond all praise; but it is not on either the magistrates or the police that we must depend ultimately for the protection of these posts. Nothing but the assistance of the public can make them really safe, and I am bound to say that in this particular there is a very marked improvement during the past year. . . . . ."

It is to be hoped that the magistrates, the police, and the public, will all take the protection of the London street alarm posts earnestly to heart, and there will then be no reason why false alarms should not become in London, if not entirely extinct, at least as rare as they are in many other large cities.

The Telegraph in the East.—On the 21st of March last the land line between Saigon and Hanoi was opened to the public. This line is 1,600 kilometres long, and serves 26 stations.

A SIMPLE TEST FOR DETERMINING THE RESISTANCE OF AN EARTH.

By F. H. POMEROY.

So far as I am aware, there has never been published any plan for measuring the resistance of an earth, which—speaking from a telegraph point of view—was thoroughly adapted to the circumstances of the case; and, no doubt, some inconvenience has resulted in consequence.

The mode hitherto pursued has been to sink two additional earth plates, and then, by a time-honoured and ancient formula, too well known to require enunciation, to deduce, from a series of three observations, the resistance of the earth required.

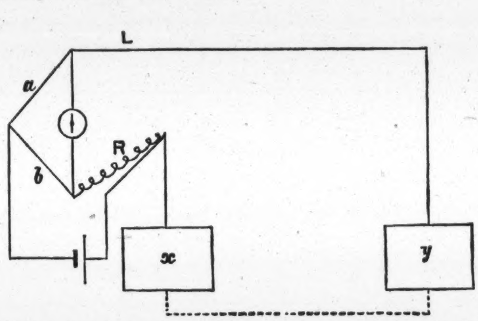
It is evident that this system is somewhat cumbrous and inconvenient, and I have devised a plan which is certainly simpler, and will for that very reason, I think, be appreciated by all those who have practically to deal with the question.

Scientists, I know, have an unholy reputation for abhorring that which is simple and clinging to that which is complex. And, if there be any truth in that legend, I am very much afraid this will not interest them.

Here is the *modus operandi.*

1st Test.

At the office where the earth, x, is to be tested, put any wire, L, to earth at its further end and test its conductivity resistance; thus—



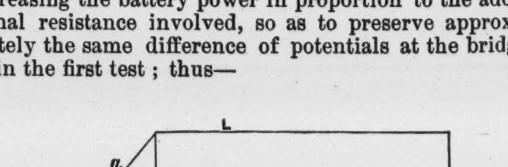
L, line, say to Blarney. x, Cork earth to be tested.

If we call the resistance of the line L, and the resistance of the distant earth y, then (if the arms a and b are equal)

$$R = L + y + x.$$

2nd Test.

Disconnect the copper of the battery from the earth, x, to be tested and join it to another line, L′, running, as far as possible, in a totally different direction, and increasing the battery power in proportion to the additional resistance involved, so as to preserve approximately the same difference of potentials at the bridge as in the first test; thus—



L, line, say to Blarney. L′, line, say to Queenstown. x, Cork earth to be tested

This test will give the difference between $L + y$ and x, and therefore (the arms a and b being equal)

$$r = L + y - x,$$

but $$R = L + y + x,$$

therefore $$R - r = 2x,$$

therefore $$\frac{R - r}{2} = x,$$

the resistance of the earth.

It therefore follows that when the earth is perfect, r (the result of the second test) will equal R (the result of the first), and no calculation is required. If the two tests differ, then the result of the second test, subtracted from that of the first and divided by 2, gives the resistance of the earth.*

Now with regard to its applicability. The majority of telegraph offices are *intermediate*, and therefore an "up" and a "down" line, serving for the second test, are ready to hand.

At those terminal offices where no second wire is available, one can readily be improvised by running a G.P. wire either to the nearest pole and connecting it to its earth wire, or to some point where a better earth might be expected.

It will be seen that the second line and its earth in the second test are common to both arms of the bridge. Their combined resistance is therefore perfectly immaterial, and even if that resistance varies, the balance is not affected, once it is obtained. The first line, however, it is apparent *must* be steady and therefore should be made as short as possible, either by selection, or by earthing at the nearest available point.

The diagrams show the method of making the tests by the bridge. If Varley's differential be used, the wires—for the second test—should be connected up as for a "numerator" test, putting L (the first line) to "good line," the earth to be tested to "bad line," and the second line to the earth terminal.

THE GOVERNMENT AND THE TELEPHONE.

On Friday last week, the Association of Chambers of Commerce waited upon Mr. Raikes with reference to the telephonic and telegraphic charges, colonial postage, and telegraphic money orders. Sir A. Blackwood accompanied the Postmaster-General. Colonel Hill, Sir A Rollit, Sir E. Birkbeck, Messrs. Maclean, Herbert Gladstone, Craig, and Jacoby, and other members of Parliament were present.

Colonel **Hill** introduced the several subjects. As to telephonic communication, the chambers considered that the present system, by which telephonic lines were in the hands of many competing companies, was not at all a desirable one. They felt that telephonic communication was a matter very much more considered than it was some time ago, and a greater desire existed for extending facilities for such communication; and in the opinion of the chambers the big towns ought to be connected with each other, and that suitable "call" offices should be established in the towns, where people might avail themselves of the use of the telephone. They desired that the telephonic lines and the whole telephonic communication should be handed over to the Post Office. The transfer of the telegraphs to the Post Office had been very satisfactory, and they believed that the same result would follow from the taking over of the telephones. If this were done the Government could bring down the telephonic charges, and the largely increased business resulting would make it a paying concern. With regard to communication with lighthouses, they desired it on two grounds—viz., the saving of life and property, and the convenience of navigation. As to the telegraphing of money orders, that would be a great boon.

Sir A. K. **Rollit**, M.P., said that there was a very strong sentiment in reference to the cheapness of communication and the absence of telephone lines, and in other ways the country did not get the full benefit of the telephonic system. The prices for private wires charged by the Post Office were practically prohibitive. Some reductions had been made, but the scale of reduction had been very slight. With the surplus of the Post Office at about three millions there was plenty of room for liberality, especially as the resources of the Post Office were equal to the new demands which they were making.

Mr. **Bayley** (Plymouth), Mr. **Plummer** (Newcastle), Mr. **Water**, and Mr. **Kenric Murray** having spoken,

Mr. **Raikes**, in reply, after referring to the subject of postage, said, as to the question of telephones, he approached that subject with caution, owing to an imperfect report of his speech having made him say that it was the intention of the Government to acquire the telephone system of the country. He did not say anything which could fairly bear that interpretation. But if they were going to have a universal system, it was quite plain that it must be either in the hands of one universal company, or it must be in the hands of the Government. He did not imagine that any of them would ask the Government to give a monopoly of telephones to any particular company, and therefore that their wishes tended towards the acquisition of the telephones entirely by the Government. But certainly this was not the most favourable moment for taking up that question with a view to action. They were familiar with the circumstances of the existing telephone companies and associations; their patents gave them something like a practical monopoly, but there would come a time when the Government would be able to treat with them on better terms than at present. He quite admitted that the telephonic system had been cramped by the conditions under which it existed, and he should be glad if any change could be made which should be satisfactory to the public. Sir Albert Rollit had told them that the prices were prohibitive. He agreed with Sir Albert; and it had always seemed to him that the charges for additional convenience, either telephonic or telegraphic, were larger than he should wish that they were; and he thought a little gentle pressure on the part of the public upon those who were the paymasters of the State might have more effect than pressure brought to bear upon himself. With regard to lighthouses, that matter was entirely in the hands of the Board of Trade. As to the telegraphic money orders, the main objection of the Government was the large balances which it would be necessary to keep at the small post-offices, and that would be a great temptation to the small postmasters. He had, however, given directions for making an experiment at Birminghan and Brighton; and if the results were satisfactory, he might be encouraged to go further. The various matters submitted to him were receiving the most careful attention of the Post Office.

The deputation then withdrew.

TAUNTON AND THE ELECTRIC LIGHT.

At the monthly meeting of the Taunton Town Council last week, in accordance with the resolution passed at the previous meeting of the Council Committee, the Watch, Lighting and General Purposes Committee reported that they would issue advertisements inviting tenders for the supply of 60 electric arc lamps. Only one tender had been received, which was from the Taunton Electric Light Company, which the committee presented to the Council. The committee recommended that in case the Council accept the tender, they should stipulate that the Council should provide and fix the posts and supports provided that the company should allow a deduction at the rate of 5 per cent. per annum upon the value of the existing posts and supports, and upon the outlay to be made in providing and fixing all other necessary supports. The company's tender was for 60 lamps in place of the present 29 for a seven years' contract, "computed from January 1st, 1889," determinable at the end of the first three or five years:—

	Per annum.
Burning an average of 6 hours per night each lamp	£17 7s. 6d.
" " 7 " " "	£18 12s. 6d.
" " 8 " " "	£19 17s. 6d.

The company were prepared to provide and fix the whole of the supports for lamps and wires, or, if the Town Council found the same, the company would allow a deduction (from the amount annually due to them) at the rate of 5 per cent. per annum upon the outlay made by the Council in providing the said support. The company also undertook to allow a deduction to the Council at the end of the present year in the event of the full eight hours average lighting not having been used, for the two years ending December 31st, 1888.

Mr. **Van Trump** proposed that the tender be accepted. The company would find supports or allow the Council to do so, and would pay the Council 5 per cent. per annum for the capital they laid out, and also, the committee understood, for the existing plant. The extra cost of the proposed extension of the electric light would be about £200 a year. In the face of the influential memorial that was presented to the Council at the last meeting, he believed the ratepayers were quite prepared to pay extra for the benefit that would thus be conferred upon them.

Mr. **George Webber** seconded the resolution.

Mr. W. **Chapman**, speaking as chairman of the Finance Committee, said, in reference to Mr. Van Trump's statement that he thought the extension of the light could be carried out without increasing the rates, there was very little hope of their being able to do it unless they were prepared permanently to increase the rates 1½d. a year. In the first year there would be extra expense for posts, &c., which would increase the rates very much beyond

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* This, however, is only correct where the resistances in the two arms of the bridge are equal. If they are unequal, the following formula should be used where a and b are the arms of the bridge:—

$$\frac{a\,(R - r)}{a + b} = x.$$

that. He did not think the times were sufficiently good to warrant their asking the ratepayers for a larger amount. In 1886 the Lighting Committee spent £746; in 1887, £1,027; in 1888, £1,360. The committee were spending nearly double the amount they spent three years ago in lighting the town. He did not think that at present the town was so badly lighted that they need go to further expense. He did not think the ratepayers were prepared to increase the rates in order to carry out the proposition of the committee.

Mr. STANDFAST endorsed the latter remark of Mr. Chapman's. The memorial that was signed by the ratepayers bore a false and misleading heading. The people who signed it were led to believe that the electric light could be extended without the rates being increased. The total cost of the present number of lamps burning for seven hours would be £615 a year, and if they had 60 on the same principle it would be £1,117 10s., or £502 18s. in addition to the present payment for 29. After deducting the amount saved by the discontinuance of the gas lamps, he contended that the extra cost would be £400 a year, and not about £200 as Mr. Van Trump said. As the Council did not know the position they would be in with regard to the sewage works, he hoped the Council would defer the matter for the present. By so doing they would be likely to benefit both the town and the Electric Lighting Company.

The TOWN CLERK made two attempts to take a division (at last successfully) with the following result:—For the motion, 7; against, 8. The resolution was therefore lost.

The objection raised by Mr. STANDFAST against Alderman Bruford, who wrs largely interested in the Gas Company, was ruled to hold good, and Mr. Fowler and Mr. Potter were also disqualified from voting on the ground that they were interested.

BATH AND THE ELECTRIC LIGHT.

AT the last meeting of the Bath Town Council the report of the committee appointed on the 2nd August last, to consider the question of lighting the streets with the electric light, was submitted. the report consisted merely of a printed tabulated statement, containing a summary of the information the committee had obtained from places where the electric light is or has been in use. The cost in all cases but that of Waterford, where it was the same as gas, was considerably above that of gas; and all the towns give an unqualified negative to the question, "Do you find the electric works a nuisance?" In presenting this information the committee stated that they now awaited further instructions.

The TOWN CLERK read the following clause in the Municipal Act:—"A member of a council shall not vote or take part in a discussion on any matter before a council or a committee in which he has, directly or indirectly, by himself or by his partner, any pecuniary interest." He took the view that members of the gas company or of any electric lighting company could not vote or take any part in the discussion.

Mr. COX said that this point before them was a very disputed one. By the Town Clerk's ruling the mouths would be shut of half the members who had been sent there by the burgesses to endeavour to prevent the waste of public money. He proposed that before the ruling of the Town Clerk be accepted counsel's opinion be taken upon the point, and he moved a resolution to that effect, the consideration of the report to be deferred in the meantime.

Mr. RADWAY seconded, as one who was interested in the electric light.

Alderman MURCH was of opinion that there being no actual proposal for the lighting of the town, but only a preliminary report, the section read by the Town Clerk did not apply at this stage, and therefore counsel's opinion on this clause was not necessary.

Mr. STURGES said to take counsel's opinion would put the Town Clerk in an invidious position; he had told them what the Act said, and what it said no one could misunderstand, unless they desired to twist its meaning; and it would be foolish, unnecessary, and ungracious to consult counsel. This matter had been threshed out at Taunton, where it was at last settled as the Town Clerk had now ruled. It was only by shutting the mouths of the gas interest at Taunton that the electric light was introduced.

Alderman MURCH moved as an amendment to Mr. Cox's motion that there was no reason for getting counsel's opinion at present, the discussion being only preliminary.

Mr. QUIN seconded, and said that although the words seemed unmistakeable, he could not think that they were meant to shut the mouths of the Council in large questions like this; but they rather related to contracts and matters of trade.

The amendment was put and lost by 16 to 12, and the original motion was carried with seven dissentients.

THE BRADFORD ELECTRICITY SUPPLY.

IN the specifications which have been issued for the various works in connection with the new scheme of "Electricity Supply" for Bradford, the one relating to the supply of main cables, &c., is probably the most interesting as developing the plan proposed to solve the vexed question of a successful underground system of conductors for electric lighting from a central station. It was suggested by Dr. Hopkinson that a brick conduit should be used; this, however, has not been adopted, but a form of underground work which may be termed "experimental" has been resolved upon, and contractors are invited to tender for the manufacture and carrying out of certain works in a specified manner, and further to maintain them in good working order for twelve months, although no experience is to be relied upon as a guide to what might possibly happen in the future. The type of cable specified for the mains, distributing mains and house service mains is precisely similar in each case, the variation in size according to the amount of current to be carried being the only structural difference. The conductors are all formed of stranded wires, varying in diameter from ·05 inch to ·10 inch, and range in sizes from 37/12s. to 7/14s., these are insulated in the following manner: "a layer of insulating material of such composition and character as will not be injured by the heating of the conductor (at the rate of 3,000 ampères per square inch of copper), and having an insulating resistance of not less than 1,000 megohms per mile." This evidently excludes certain dielectrics, as the effect of temperature on the insulation is not mentioned, consequently we may suppose that any of the usual methods of insulating underground conductors are not thought of; that this is so the following would also show. The insulated *conductor is to be surrounded with "a metallic casing of lead, or an alloy thereof, which shall be most suited to resist chemical action from acids in the ground, or from other substances which may come into contact with the cable. This solid-drawn lead pipe must be forced or drawn on without splits or flaws in soldering." Jute or other suitable material, well tarred, &c., is to form an outside covering, being either braided or laid on so as to form a hard, firm, compact mechanical protection from external injury, and also to provide a waterproof or damp-resisting casing against wet penetrating from the outside.

As these cables are simply to be deposited in a trench dug about two feet deep and then covered in like an ordinary water or gas pipe, there will be evidently ample opportunity during the first 12 months for the protected lead cable exhibiting its damp-resisting qualities. We may add that the work of opening the trenches and filling in again and making the roads good will be carried out by the Corporation itself, so that the contractor will not have the satisfaction of having his own men to carefully cover and protect his cables. Some sharp pointed stones or foreign substances well punned into the cable may not tend towards its lasting qualities. Sufficient has been shown to prove our remarks that the design is experimental, the form of the cable with such light external protection must be considered as "hazardous" to be placed in the bare ground. The use of various forms of underground conduits in the United States have generally proved failures; but that can be no reason why no conduit whatever should be used. The experience of the durability of iron piping for our underground telegraph wires appears to have been lost sight of. The lead pipe would appear to be used in connection with the insulator simply to preserve it air-tight and water-tight, and the quality specified is very general. On this question of lead piping experience is very misleading, if looked at from the ordinary point of view. We have specimens of pipe used for the purpose of carrying water which have been in use (and, in many cases, are so at the present time), for hundreds of years in a perfect state of preservation. On the other hand, we have numerous instances of lead-covered cables in the towns of the United States which have not lasted for two years. There is, therefore, lead and lead. In the former case we have indisputable proof that lead can be obtained which can be made into pipes practically everlasting, and in the second case we have equal proof that lead has been used which must be very dissimilar in quality, as it cannot be manufactured into a lasting piece of work.

It is very easy to insert in a specification that the metallic covering of lead or an alloy "shall be most suited" for the ends desired, but who is to judge of this when it will necessitate the experience of several years' test before the suitability of the material can or cannot be proved. We are of opinion in this matter that price has more to do with the durability of lead piping than anything else. There are evidences throughout the specifications that the practical electrical engineer, thoroughly acquainted with underground conductors, their construction and manner of definition, is especially distinguished by his absence from having given any advice or instruction. There are many conditions and points in this specification to which objection will be generally taken, amongst these being the repairing by the contractor of faults occurring during the 12 months' guarantee (fancy guaranteeing for 12 months an experimental cable), and the arbitrary manner in which the contractor's hands are tied by the Corporation officials.

It cannot be too strongly remarked that the crucial point upon which the future success of central station lighting rests, is the successful employment of permanently good conducting mains, and that if these are to be frequently out of order, no further extension of the system can be reasonably expected; but it certainly cannot be advantageous to the adoption of a system of central station lighting in a new locality, to embark at once upon an experimental type of mains and distributing conductors. It were better that the experiments be carried out on a tentative plan, and when successful, applied to a permanent scheme, such as that now proposed, and not to carry out experimental researches at the expense of contractors and corporations, with the accompanying risk of the failure of the "electricity supply."

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* A testing wire, No. 15, is to be embedded in the insulating layer, but completely insulated from the main conductor.

LORD CRAWFORD'S ELECTRIC LIGHTING BILL.

NOTHING could be more eloquent of the unsatisfactory nature of the existing legislation upon electric lighting than the Bill which was debated and read a second time in the House of Lords on Tuesday evening. Lord Thurlow had already brought in a modest measure of five clauses, the main point of which was the substitution of forty-two years for twenty-one, under the Act of 1882, as the period at the end of which a local authority may purchase a lighting installation. This Bill has, so far, progressed up to the committee stage without arousing much interest; but the Bill which the Earl of Crawford has thought it necessary to introduce is of quite another character, and will evoke a great deal of feeling and discussion. Already some strongly-worded and very numerously signed petitions have been presented against it, and the House of Lords on Tuesday devoted an unusual amount of time to the measure, considering that it comes from a non-official peer. Including "short title" and "interpretation," this Bill contains 67 clauses, whereas that of 1882 embraced only 37. It is, in fact, a very elaborate and complete measure, and is even prefaced by a memorandum stating, first, that "the provisions of the Electric Lighting Act of 1882 have been found by experience to be of a nature so stringent as to shut out the public from the advantages they were presumed to obtain from commercial application of scientific knowledge," and next, "that the greater part of the details of the Bill have been adapted to the present circumstances from the Gasworks Clauses Act, 1871, and which are, in fact, precisely the law as regards the parish of Chelsea under an Act passed on the 25th September, 1886, and, so far as consistent with a public Act, the provisions of the Chelsea Act have been brought into this Bill." The memorandum also explains that "the principal changes of the existing law proposed by this Bill are (*a*) freedom of contract as between local authorities and undertakers (additional to present forms of procedure); (*b*) payment to local authority of rent for wayleaves; (*c*) mains and cables to be underground after a certain lapse of time; (*d*) terms of purchase by the local authority." This preface is useful, inasmuch as within our limited space it is impossible to deal exhaustively with a measure of this length.

As Lord Crawford observed in asking the House to read the Bill a second time, the second clause provides that "undertakers," who provide the currents of electricity for distribution to individuals within a certain area, may make their arrangements with the local authority as a licensing authority, and so save the time and the heavy expense of having to apply to the Board of Trade for a provisional order, which must subsequently be embodied in a special Act of Parliament. They will also have the advantage of being able to proceed when Parliament is not sitting, instead of being obliged to wait for a fresh session, as would be necessary under the existing system. And if a local authority refuses a licence, the Board of Trade may be appealed to and the local authority be dispensed with. Clause 3 provides that the electricity supplied for public or private purposes shall be supplied only by such means as the Board of Trade approve of, either for general or special use, and subject to regulations for securing the safety of the public, and ensuring a proper supply of electricity. In connection with this clause, Lord Crawford mentioned that the Phœnix Insurance Company, although charging no extra premium in respect to premises supplied with electric light, issued in 1882 certain special rules for the guidance of consumers of the light, with a view to protection against fire and life, and he urged that the Board of Trade in imposing conditions under this clause, should give great weight to those rules. Clauses 4, 5, 6 and 7 deal with the breaking up of streets, the notices to be given, and other conditions, similar to the Gas Act of 1847, which were embodied in the Act of 1882. The next two clauses regulate the alteration of sewers, or other pipes or wires which may interfere with the undertakers' rights under this Bill; clause 10 requires them to give notice and full particulars to the parties interested if they propose to lay down wires which may affect existing telegraph or telephone wires, and clause 11 empowers the local authority to require in lieu of rates and taxes an annual rent or charge from the undertakers for wayleaves granted, at the rate of and not exceeding £20 per mile of any trench sunk or dug for laying their wires. The next important clause is clause 13, which proposes to enact that within five years from the passing of the Act all mains, cables, or wires for transmitting electricity for motive power, now placed over houses or streets in populous places, "shall be placed below ground," unless consent has been granted by the local authority under such conditions and regulations for the protection of the public safety as may be prescribed by the Board of Trade. Clauses 16-23 regulate the question of inspection and testing, and 24 to 29 deal with instruments which undertakers will be required to keep. Clause 30 requires the undertakers, upon the application of any owner or occupier within 25 yards of a distributing main, to give a supply of electricity and lay such mains as may be necessary for the purpose, subject to certain conditions as to payment, notice and so on by the applicant, and it also provides that if such owner or occupier uses any form of lamps, or uses the supply or deals with it in any way so as to unduly or improperly interfere with the supply of electricity to any other persons by the undertakers, the undertakers may stop the supply so long as such uses continues. The next three clauses deal with maximum current, supply to public lamps, and penalties on undertakers for failure to supply. The 34th clause provides that undertakers may charge for a supply to any ordinary consumer—(1) By the quantity of energy contained in such supply; (2) By the actual quantity of electricity so supplied, or unless the Board of Trade from time to time otherwise direct; (3) By the number of hours during which the supply is actually used by the consumer, and the maximum current to which he is for the time being entitled—provided that before commencing to give a supply for general purposes the undertakers inform the local authority by what method they propose to charge; and when they have given such notice they shall not be entitled to change the method except after a month's notice to the local authority and to the consumers. But by clause 35 the undertakers may make special agreements with individual consumers. The price for a supply to the public lamps is (clause 36) to be settled by agreement; but (clause 37) (*a.*) Where the undertakers charge any consumer by the quantity of energy contained in the supply given to him, they shall be entitled to charge him at the following rates per quarter:—For any quantity up to 12 units, £5; and for each unit over 12 units, 8s. 4d. per unit. (*b.*) Where the undertakers charge any consumer by the actual quantity of electricity supplied to him, they shall be entitled to charge him according to the rates set forth in the preceeding paragraph, the quantity of energy contained in the supply given to him being taken to be the product of the actual quantity of electricity supplied to him, and the standard pressure at the point of junction of the mains and the service lines by which he is supplied. (*c.*) Where the undertakers charge any consumer by the number of hours during which he actually uses his supply, they shall be entitled to charge him at the rates above specified, the quantity of electricity supplied to him being calculated on the supposition that the consumer uses the maximum current specified by him under the provisions of this Act during all the hours that he has used the supply. Provided that nothing contained in this section shall debar the undertakers from charging a higher price per unit with the consent of the local authority." The next 10 clauses deal with meters and apparatus, clauses 48 and 49 with notices, 50, 51 and 52 with insolvent undertakers, unprofitable undertakings, and revocation of agreements by the Board of Trade. Clause 53 makes provision for the purchase of an undertaking. It proposes to enact that if the Board of Trade have revoked an agreement, and given notice thereof, the local authority may, within one month after such notice, require the undertakers to sell to them their undertaking, or so much of it as is within the area of the supply, and the undertakers shall so sell to them upon the terms of paying the then value of all land, buildings, works, materials and plant suitable to and used for the purpose of the undertaking within such area, such value to be estimated in the manner following:—The price to be paid to the undertakers for their undertaking shall be an amount equal to the average market value of the shares or stock during the five years immediately preceding the notice requiring the undertakers to sell. The clause next provides that where no such purchase is effected by the local authority under the above conditions, and any local authority, company or person is willing to purchase the undertaking or part of it, the Board of Trade may, with the consent of the local authority and the undertakers direct the transfer to such company or person on payment of the price thereof. Where no purchase and no transfer is effected, the local authority or other persons liable to repair the street in which the undertaking exists, may remove such works at the cost of the undertakers. The remainder of the clauses are of the usual general character, involving no special issue.

In support of his proposals, Lord Crawford, among other things, said he did not desire to give electric light companies any permanent monopolies; all he wished was that they should be placed in no worse position than when they entered into their contracts. If the Bill were passed, a great industry which had been retarded for six years would have room for development and the exercise of capital, and he knew that if the law were altered in some such way as this, within six or eight months large sums of money would be thrown into the industry, and employment provided for a large number of working men. Lord Thurlow agreed to some extent with what Lord Crawford had said, but he did see his way to withdrawing his own Bill. Only a large amelioration in the existing law would set free the large amount of money ready for investment, but a measure so complex as this would have but a faint chance of finding acceptance in the House of Commons, even if it passed this House. Another objection was that it was yet too soon to reopen the whole question, and all that was wanted was a simple measure giving relief to the companies in the form of an extension of time in which to recoup themselves, so that they need not charge their customers excessive prices. He further thought that so large and important a measure as this ought to be introduced by the Government, and that the Bill legislated on many points of detail which ought to be left to Provisional Orders, according to the merits and circumstances of each case. The Earl of Onslow (representing the Government) adversely criticised the measure on many points, but added that as the Government was anxious to do all they could to encourage electric lighting, he thought the Bill had better be read a second time and then referred to a Select Committee. Lord Herschell feared there was little hope of this Bill passing the other House this session, but he advised its being read a second time, and at the same time urged that Lord Thurlow's Bill, having already gone through that stage, should be allowed to proceed. Eventually the Bill was read a second time, and will now be considered by a Select Committee.

INCANDESCENT LAMP PATENTS.

Edison and Swan United Electric Light Company v. Holland and others.

This long-pending case came before Mr. Justice Kay on Tuesday, when the Attorney-General, Mr. Aston, Q.C., Mr. Moulton. Q.C., and Mr. Bremner (instructed by Messrs. Ashurst, Morris, Crisp, & Co.) represented the plaintiffs; and Sir Horace Davey, Q.C., Mr. Finlay, Q.C., and Mr. J. C. Graham (instructed by Messrs. Renshaws) the defendants.

The Attorney-General, in opening the case, said the plaintiffs were the Edison and Swan United Electric Light Company, Limited, and the Edison Electric Light Company, Limited, who were the assignees of Mr. Edison's patent, dated November 10th, 1879, for incandescent electric lamps, and the assignees of a patent generally called the Cheesbrough patent, that being the name of the patent agent through whom it was taken out, the inventors being Messrs. Sawyer and Man. The defendants were Mr. William Holland, the Jablochkoff and General Electricity Company, Limited (now the United Electrical Engineering Company, Limited), and the Anglo-American Brush Electric Light Corporation, Limited. Mr. Holland was last year the occupier or tenant of the Albert Palace at Battersea, where a large exhibition was held and a great number of electric lights used. The Jablochkoff Company put up the installation, and the lamps were supplied by the Brush Corporation, who were brought in as third parties, there having been an indemnity of some kind. Practically the latter, a powerful company engaged in manufacturing dynamos and electric lamps on a large scale, were the real defendants. It was not necessary for him (the Attorney-General) to go into very great detail in opening, for the case which the plaintiffs would now rely upon was identically that which they submitted in the action against Messrs. Woodhouse and Rawson, in which Mr. Justice Butt gave a decision in their favour, that decision being upheld in the Court of Appeal. Everyone of the anticipations alleged in this action were set up in the previous case, so far as they depended upon the construction of written documents. The Attorney-General gave a popular explanation of the two specifications, and then proceeded to call evidence.

Sir Frederick Joseph Bramwell, F.R.S., examined by Mr. Aston, Q.C., said he was acquainted with the specifications relating to the action, and also with the anticipations alleged. The earliest attempt to make an incandescent lamp was that of King in 1845. King proposed two modes of working an incandescent lamp, one by means of a platinum strip which was to be made incandescent in the ordinary atmosphere, the other by means of a piece of carbon made by a saw or file out of a larger piece of carbon and enclosed in a Torricellian vacuum. In 1852 Roberts proposed to use a piece of carbon, about half an inch by half an inch, and as thin as it could be made, in a lamp rendered vacuous by an air pump, there being a connecting pipe and a stop-cock, the upper part of the lamp being of glass secured in some way into a metallic base. In that case there was not a chamber entirely of glass, and, as in King's case, the carbon was cut out of a piece of carbon already existing. Mr. Justice Kay suggested that these were matters which might be left to the defendants to elaborate. The witness turned to the specification of Edison, which he said was amply sufficient to enable incandescent lamps to be made in the manner desired by the patentee. So far as he knew, the lamp described and proposed to be used by Edison was entirely new at the date of the specification. He (witness) knew of no commercially successful incandescent electric lamp having been used prior to the date of Edison's patent. He had some recollection of seeing a platinum-iridium incandescent lamp exhibited and giving a very fair light; but since carbon filaments had been available he had never known anybody attempt to use such a lamp. All incandescent lamps were now made with carbon filaments, except that there might be some lamps of such enormous size which were incandescent and which used carbon, upon which the question would arise whether the light-giving conductor could be called a filament in the ordinary sense of the word. He had examined lamps said to be of the defendants' manufacture. These were in a highly-vacuous condition, and they were incandescent lamps, possessing a resistance when cold varying from 60 ohms in two cases up to 195 or 200 ohms in one case, and four of them were of 135. So far as could be judged by the eye the filaments were undoubtedly of carbon. Assuming that the filaments were carbonised after being formed into filaments, he could perceive no difference between the lamps of the defendants and those professedly made under the plaintiffs' specification, except in points of very minor detail. There was some sort of secondary wire spoken of by Edison between the carbon and the clamp which was not in these lamps, the carbon being connected direct to the leading wires, which were fused through the glass. But until he was shown differently he should consider them to be practically Edison lamps. The witness was then examined upon the Cheesbrough patent, and described the process of "flashing," which is covered by that patent. The specification appeared to him to be sufficient, and he thought there was one obvious reason why it must be so, for the patentee directed that such a heat should be maintained as would effect the decomposition of the deposit. The appearance of the filaments in the defendants' lamps was consistent with their having been treated by the process which Cheesbrough described. In cross-examination by Mr. Finlay, Sir F. Bramwell said he believed lamps had been made under Edison's specification--lamps for commercial purposes, and used commercially—apart from subsequent improvement. Only one improvement occurred to his mind, which was in the making of the vacuum after the current had been passed through. Not to his knowledge were any additional and secret processes employed to make the lamps perfect. He knew of a secret process employed in the manufacture of the lamp for the purpose of economy in manufacture and getting better commercial results, but he knew of none employed for the purposes of improvement in the lamp. His view of the patent was that there was disclosed in it an incandescent carbon filament lamp, the filament being formed to shape before carbonisation, the lamp being wholly of glass and a high vacuum having been made in it, and the leading wires being fused through the glass. He did not think it would be right to say that the great development of incandescent lamps in 1878 was due to improvements in dynamos. He should say that the invention of Sprengel's pump greatly facilitated the manufacture of incandescent lamps. The object of the coiling of the filament described in Edison's specification was to get an adequate resistance; if more light were required, less of the filament would be coiled. Any workman of reasonable sense would understand that the filament was to be coiled no more than was needed to maintain the proper balance between the resistance and the light-giving power. By the word filament he understood something which was in regard to size of thread-like character. When applied to lamps, the best illustration of Edison's meaning was to be found in the fact that he said an actual cotton thread might be taken and carbonised. Where the limit of a filament was he could not say. The mention of "carbon wire or sheets" no doubt pointed somewhat away from the idea of the filament. In his specification No. 5,127 of 1879, Edison apparently applied the term filament to something which was of flat section. Taking some kinds of conductors, there was nothing novel in the idea of obtaining small sectional area for the purpose of increasing the resistance; but as regards carbon it was certainly novel. It was perfectly clear that Lane-Fox was fully aware of the value of high resistance in incandescent lamps, and of producing that high resistance by reducing the sectional area of the conductor.

On Wednesday Mr. Finlay continued his cross-examination of Sir Frederick Bramwell, endeavouring to elicit the admission that filaments made in accordance with the directions in Edison's patent were never used, and would, in fact, be useless. Sir Frederick maintained, however, that he had seen, both in New York and in England, filaments which, in his view, were made in accordance with Edison's directions. The paper of Despretz being put to the witness as an anticipation of Cheesbrough's specification, he said he thought Despretz obtained an analogous result to that of Cheesbrough, but whether he did it by Cheesbrough's process or not was not quite clear.

Dr. John Hopkinson, briefly examined by Mr. Moulton, agreed with the evidence given by Sir Fredk. Bramwell. In cross-examination by Sir Horace Davey, he said that previous to Edison's specification there had been no experience, so far as he knew, of carbonising threads or fibres. Edison simply said the material was to be "properly carbonised in a closed vessel," but that would be a sufficient description to an intelligent workman, especially if he knew a little about chemistry. It would require no experiment, but some thought, to properly carry out the process. He did not infer from the specification of March 16th, 1881, that Edison himself considered that he had not previously sufficiently described methods of manufacture of filaments; the later specification merely showed that he thought he could suggest a method which contained improvements in detail. There were many loose expressions in Edison's specification, but it was possible to understand what they meant. The burner in Mr. Swan's lamp was not in his judgment a filament; its cross-section was so considerable in comparison with its length, and it was not flexible. Filament was a descriptive term; it was a mere question of degree and he could not say where the line of division between that which was and that which was not a filament occurred. He did not know that prior to November, 1879, Mr. Swan was making lamps with a horseshoe-shaped filament.

On Thursday the cross-examination of Dr. Hopkinson was continued, attention being directed to the alleged anticipations with regard to the paper of Despretz. His impression was that the piece of carbon on which the deposit took place was introduced cross-wise in the electric arc, though he was bound to say there was nothing to fix absolutely whether it was done in that way or in the manner described by Cheesbrough. The material produced was identical with that produced by the Cheesbrough process.

Mr. John Imray was convinced from the language of Despretz's paper that the heat of the arc was applied to cause the deposit. In other respects he supported the evidence of the previous witnesses.

Mr. Edward Gimingham gave evidence of having made several lamps in accordance with the directions in Edison's first specification. These lamps had given good light and were practicable lamps.

Dr. Fleming gave the results of tests he had made of the lamps made by the previous witness, and in regard to one, the "filament" of which was of cardboard and of considerable sectional area, admitted that it was of very low resistance.

Sir Horace Davey's cross-examination was directed to establishing similarity between this lamp and that of Mr. Swan with the carbon pencil of $\frac{1}{25}$th of an inch diameter.

Mr. Aston said this closed the plaintiff's case, and he should withhold any comments he might have to make until a later period.

Sir HORACE DAVEY, in opening for the defendants, said his submission would be that Edison's patent disclosed nothing novel, but only stated a scientific principle without disclosing how that principle was to be carried into effect. The principal anticipation relied upon would be the lamps of Mr. Swan and Mr. Stearn, which were exhibited to various persons, and used for house lighting, months before the date of Edison's specification. He had not concluded his opening when the court rose, the case standing adjourned until Monday next.

NOTES.

Electric Lighting Act Amendment.—At a recent meeting of the electrical trade, held at the offices of the Anglo-American Brush Electric Light Corporation, Limited, it was decided to petition in favour of Lord Thurlow's Bill now before the House of Lords to amend the Electric Lighting Act of 1882, and we understand that the petition has been extensively signed by the principal electrical companies and firms representing the scientific interests of the industry.

Electric Lighting in Germany.—A committee, appointed by the Town Council of Breslau to enquire into the best means of installing the electric light in the town, has reported in favour of a large central station to supply 5,000 lamps, distributed throughout an area the boundary of which is at no point farther than 1,200 metres from the generating station. It is not intended, says *Industries*, to ask public tenders for this installation, but to entrust it to Messrs. Siemens and Halske, of Berlin, who will submit an estimate based upon a general plan of the district. The management of the central station will be in the hands of the municipality. These recommendations of the committee have not yet been finally adopted.

The Electric Light at Rouen.—The Thomson-Houston Company has fitted up the works of M. Désiré Giron with 9 arc lights of 1,200 candles each. The Thomson-Houston dynamos employed for this installation are also used during the evening for supplying current for 9 arc lights in the grounds belonging to the Horticultural Society; these lights are used for the purpose of experimenting on the effect of the electric light on plants. The motive power is obtained from a fall of water situated at about 1,500 metres distance.

MM. Condors have obtained the contract for fitting up the church of St. Ouen with 100 arc lights of 2,000 candles each, and a chandelier of 350 incandescence lights. A Lacroix engine of 150 H.P. will be used. All machines must be placed at a distance of 2,700 metres from the church.

The offices of the *Patriote de Normandie* will be shortly fitted up with the electric light. The work is now in progress.

The Municipal Council has under consideration several tenders for the electric lighting of certain public buildings, and MM. Condors are engaged in negotiations with the Council for the installation of a central electric light station.

Sheffield and the Electric Light.—The Corporation of Sheffield was last week recommended by a local firm to adopt the electric light for the principal streets of the town, the said local firm expressing its readiness to estimate for the work at a small profit. The letter containing the recommendation was referred to the Watch Committee, the Town Clerk remarking that, in view of the new powers to be given to the Corporation by the Local Government Bill, he did not think the Town Council would sanction the adoption of the electric light at present.

Church Lighting by Electricity.—The Blockley Electric Lighting Company is about to light the parish church of Blockley, a large village on the southern border of Worcestershire. The machinery will be driven by water-power, of which there is an abundance available.

Electric Lighting of the Victorian Chamber.—A commission is sitting in Melbourne to hear the evidence of experts as to the best methods of lighting the Legislative Assembly Chamber by electricity. Mr. P. Kerr, architect of the Public Works department, has drawn up a report which shows that in October, 1882, Messrs. W. H. Masters & Co., and the Australian Electric Company, Limited, both wrote offering to light the Chamber by electricity, the latter offering to do it at the same price as was being paid for gas. Mr. Kerr drew up particulars and obtained tenders from these two firms, but neither was accepted, it being deemed desirable, in order that some idea might be formed of the effect of electric lighting, that the two chambers should be temporarily lighted by the rival companies. This was done. An Electric Lighting Board was subsequently appointed by the Parliament Buildings Committee, and they, in their report of the 30th October, 1883, recommended that a complete installation should be provided, worked by the Parliament House employés. In accordance with the recommendations of the Electric Lighting Board, competitive designs and tenders for lighting the whole of the Houses of Parliament were invited, and were opened on the 27th March, 1884. After some delay the Parliament Buildings Committee recommended the acceptance of the Australian Electric Company's tender amounting to £5,062 19s. The contract was signed on the 16th June, 1884, and was satisfactorily completed by January 15th, 1886. Certain alterations and removals were afterwards urged as being necessary, and tenders for carrying out this work and for the extension of the installation were obtained, but on April 5th, 1886, the Parliament Buildings Committee decided that no further action should be taken until Parliament had expressed its opinion.

Cathedral Lighting.—Bristol Cathedral is to be lighted by electricity. It will be used for the first time at the special evening service on June 8th, which is to be held in celebration of the completion of the western towers.

St. James's and the Electric Light.—At the meeting of the St. James's Vestry on April 12th, the Lighting Committee recommended that the consent of the Vestry be given to the St. James's and Pall Mall Electric Lighting Company applying to the Board of Trade for a licence under the Electric Lighting Act, 1882, subject to the company agreeing to the modification made by the committee in the draft licence, and to any alterations being made in the clauses relating to technical questions which the Board of Trade may require. Mr. Winnett hoped the Vestry would pause before adopting this recommendation. Again and again electric lighting companies had tried to get possession of the area which this company also desired to be compelled to light. Why was it that this part of the parish of St. James was always so much coveted by these companies? Because it was the most valuable for electric lighting of any district in London. When the companies were asked to include other parts of the parish under the compulsory clauses they always politely but firmly declined. The Vestry had received very short notice of this matter, and it behoved them to inquire closely into the constitution of the company before handing over to it a valuable district to the exclusion of others. It was all very well for a company to propose to light this district. It was quite another thing to do it. One company which had applied to that Board had spent £100,000 in the endeavour to make electric lighting supply a commercial success. Yet it had failed. What probability was there that this new company would be more successful? He trusted the Vestry would at least take more time to consider the proposal. Mr. Tapping took the same view as Mr. Winnett. Mr. W. Jenkins defended the action of the committee. Mr. Dixey moved, and Mr. Osborn seconded, that the matter be referred to a committee of the whole Vestry for further consideration. This was carried.

Train Lighting.—Mr. Killingworth Hedges states that he has had the opportunity of examining the two methods of oil-gas *v.* electricity for some time used on the Glasgow City and District Railway. The electric system was designed by the company's electrician, Mr. Carswell. A third insulated rail is laid through the tunnels only; the current is collected from this rail by means of a roller contact fixed to each carriage, and after passing through the lamps returns by the ordinary metals. The whole arrangement works automatically and gives no trouble; the cost for engine power and wages = ·33 of a penny per hour; lamp renewals = ·07 of a penny per hour; total = ·4 of a penny per hour. At present 170 carriages are fitted, but the plant in use would light five times this number, and then the actual working cost would be less than that of Pintch's oil-gas, which is charged to the railway company at 7s. 6d. per 1,000 cubic feet, and works out at a cost of ·16d. per lamp per hour, exclusive of cost of cleaning and lighting. The practice of carrying the gas in cylinders under the carriages is very dangerous; a serious accident occurred on the Berlin-Potsdam Railway; a goods train collided with a passenger train, the goods engine piercing a gas cylinder under the passenger train and setting fire to the liberated gas, which burnt the three persons in the carriage to cinders. This seems a conclusive argument in favour of electricity for train lighting, even though on a small scale it is a little more expensive.

House Lighting.—The electric light has been introduced into the house of the First Lord of the Treasury, and it is anticipated that the owners of other houses in Grosvenor Place will emulate Mr. Smith's example.

Borough of Bradford Lighting.—The time for sending in tenders has been extended to May 1st as may, by those interested, be seen in our advertising columns.

The Telephone in Austria.—It is announced that the Administration of Telegraphs is about to erect a direct telephone line between Vienna and Buda Pesth.

The Van Rysselberghe System in Switzerland.—On page 283 of the REVIEW for March 16th appears a leaderette which was based upon an announcement that the Van Rysselberghe system had been abandoned in Switzerland. This information was derived from a foreign source, and we are glad to learn that it was incorrect. The following letter, translated from the *Bulletin International de l'Electricité* for April 9th, will make the matter clear:—"In the number of March 26th of your valuable paper you state that the Administration of the Swiss Telegraphs has given up the Van Rysselberghe system on the line between Basle and Zurich which had been fitted up as a trial, because the results proved entirely unfavourable. We do not know where you may have got that information from, since it is utterly wrong. We hold an attestation to the contrary from the chief of the Swiss telephonic network, the publication of which would occupy too much room in your paper, but which we hold at your disposal. It appears from the said document that the two telephonic communications between Basle and Zurich are working regularly. On the other hand, it was not as a trial merely, as you seem to think, that the Van Rysselberghe system was applied to the telegraph lines between Basle and Zurich. Its success had long ago been proved in Switzerland. In fact, thanks to the initiative of the Administration of Telegraphs in that country, who had commenced negotiations in 1883 with our firm for a proposed trial of the system, a telephonic and telegraphic service was opened between Lausanne and Geneva in 1884. At present from the last official statement, the Van Rysselberghe system is applied in Switzerland on 536 kilometres of telegraph wires. Trusting you will be kind enough to publish this correction in your next number, we remain, &c. (Signed) MOURLON & CO., Licensees of the Van Rysselberghe patents."

Germany and England.—At a recent sitting of the Budget Committee of the German Reichstag, the Director-General of Telegraphs announced that the tariff between England and Germany will be considerably reduced, owing to the purchase by the English Government of the Borkum-Lowestoft line, and by the German Government of the Grutsiel-Valencia line.

Telegraphic Communication between London and Paris.—We read in *La Lumière Electrique* that there is still much dissatisfaction expressed with regard to the telegraphic service between London and Paris. In London complaints are made as to the formalities with which the Paris Administration hampers the working, while in Paris the blame is laid upon the want of cable accommodation. It appears that even in Government Administrations "the man at the other end" is the one always in error.

Communication with Light-Vessels.—In reply to Sir George Baden-Powell in the House of Commons on Monday, Sir Michael Hicks-Beach said: I can only repeat what I recently stated to a large and influential deputation, that the subject of communication with light-vessels and lighthouses was considered last year by a Departmental Committee, who have expressed an opinion that the experiments at the Sunk light-ship should be continued for a further period of 18 months. I would, however, point out that the question of naval defence of the country, and the question of communication between coastguards and distant signal stations, are matters for the Admiralty and Post Office, subject to the Treasury, rather than for the Board of Trade.

Heating Effect of Electric Currents.—A contemporary says: "M. Cailletet, a French electrician, has conducted a series of experiments which show that the heating effect of an electric current, as shown in a piece of platinum wire, is proportionately diminished as the pressure of the air around such wire is increased. The converse has long been established. M. Cailletet has shown that a current which would fuse a wire under ordinary pressure will scarcely raise it to redness when the pressure is sufficiently great. This shows how essential free convection and radiation are to the incandescence of the filaments of glow lamps."

A Little Dispute.—With regard to the account of the Eastbourne Electric Light Company for lighting the local Town Hall for the three months ending December 25th last an offer has been made on the part of the Corporation to pay the sum of £50, without prejudice, for the six months ending the 25th ult.

The Society of Telegraph-Engineers and Electricians.—At the extraordinary general meeting to be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, S.W., on Thursday, April 25th, a paper will be read "On the Risks of Fire incidental to Electric Lighting," by Mr. W. H. Preece, F.R.S., Past President.

The Arc Lamp in Lanterns.—At the meeting of the Royal Society on the 12th inst., a small arc lamp was most successfully used in a lantern for projecting the various illustrations in the paper read by Mr. Norman Lockyer. The remarkably steady, silent light given by the lamp was much admired, and the experiment proved that, wherever the necessary current is available, all other forms of lamp will in future have to give way to the arc for such purposes. The lamp was a "Brockie-Pell" taking about 5½ ampères, and the current was supplied by the accumulators used for lighting the hall. The lantern was one which has recently been supplied by Messrs. Drake and Gorham to the Royal Society, to which institution they act as electrical engineers. In addition to the condenser and ordinary lenses it has been fitted with a special prism arrangement for projecting horizontal surfaces on the screen. Mr. Gorham had charge of the electrical arrangements during the lecture.

Parliamentary Reports and the Press.—The *Manchester Evening Mail* of the 18th instant says: "Important proposals are at the present time under consideration for facilitating the transmission of parliamentary reports to the London and provincial press. The Postmaster-General has been asked to allow the pneumatic tube running from the House of Commons to Fleet Street to be used for the carriage of despatches intended for publication in the metropolitan and provincial journals. This would be a great convenience to the newspapers whose offices are near the Fleet Street Post Office, inasmuch as it would result in a considerable saving of the time now occupied by the messengers going to and from the House. It is ascertained that such a scheme would involve an outlay of between £5,000 and £6,000, but the whole of this expenditure would be met by a fixed charge to the newspapers making use of the tube, and in course of time the agency would, no doubt, become a source of profit to the department. In connection with the same scheme, Mr. Raikes and Mr. Plunket (the First Commissioner of Works) have been asked to provide telegraphic accommodation in direct connection with the Press Gallery of the House of Commons, so that the necessity for using the telegraph office in the octagonal hall may be obviated. If carried out, this proposal would secure a double advantage. In the first place it would expedite the transmission of Parliamentary news over the public telegraph wires; and, in the second, would put an end to the nuisance caused by the small army of boys who are now continually running to and fro between the Press Gallery and the telegraph office downstairs. The authorities are convinced of the importance of the recommendations, and serious consideration is now being given to them."

NEW COMPANIES REGISTERED.

Electric Date and Time Stamp Company, Limited.—Capital £100,000, in £1 shares. Objects: To acquire the benefit of an invention of an electro-mechanical date and time stamp (Provisional protection No. 15,717, dated 16th November, 1887.) Signatories (with 1 share each): H. Lockwood, 93, Chancery Lane; F. R. Frolich, 32, Princess Road, South Norwood; R. C. Dover, 155A, Upper Thames Street; W. Brown, 11, Queen Victoria Street; J. J. Nolan, 19, Lyndhurst Road, S.E.; E. J. Summers, Croydon Road, Anerley; E. W. Gallagher, 43, Camden Grove, Peckham. The signatories are to appoint the first directors. Qualification: £250 in shares or stock. Remuneration, £800 per annum. Registered 13th inst. by McDiarmid and Leather, 5, Newman's Court, Cornhill.

Southampton Electric Light Company, Limited.—Capital £30,000, in £5 shares. Objects: To carry on the business of electricians, and of an electric light and power company in all branches. Signatories (with 1 share each): J. H. Aldridge, M.D., J. Bishop, E. G. Rose, J. A. Millbrook, R. C. G. Fauvre, J. Miller, E. Brown, R. Allery, all of Southampton. The signatories are to appoint the first directors. Qualification: £250 in shares. Registered office, 9, Portland Terrace, Southampton. Registered 14th inst. by R. Jordan, 120, Chancery Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

United Electrical Engineering Company, Limited (formerly the Jablochkoff and General Electricity Company, Limited).—The annual return of this company, made up to the 3rd inst., was filed on the 13th inst. The nominal capital is £20,000 in 200 shares of £100 each. 180 shares have been taken up and the full amount has been called thereon. The calls received amount to £10,500; £6,500 is considered as paid, and there remains £1,000 of unpaid calls.

Liverpool Electric Supply Company, Limited.—At an extraordinary meeting of the members of this company, held on the 12th ult. at 1, Crosshall Street, Liverpool, a resolution was passed authorising certain alterations in the articles of association. The resolution was confirmed at a meeting on the 28th ult., and was duly registered on the 13th inst.

Simplex Electric Light and Plant Company, Limited.—An extraordinary general meeting of the shareholders in this company was held at 6, Howarth's Buildings, Manchester, on the 6th inst., when resolutions were passed authorising the winding up of the company, it having been proved to the satisfaction of the meeting that by reason of its liabilities the company cannot continue its business. Mr. A. H. Pownall, of 69, Prince's Street, Manchester, was appointed liquidator. The resolutions were duly filed on the 11th inst.

Great Western Electric Light Company, Limited.—The final meeting of this company was held on the 3rd ult., when a statement was submitted showing the way in which the winding up has been conducted, and the property of the company disposed of.

Brush Midland Electric Light and Power Company, Limited.—The final meeting of this company was held on the 3rd. ult., when an account was given as to the manner in which the winding up has been conducted, and the property of the company disposed of.

CITY NOTES, REPORTS, MEETINGS, &c.

Electrical Power Storage Company, Limited.

THE seventh ordinary general meeting of this company was held yesterday (Thursday), at Winchester House, Old Broad Street, Sir Daniel Cooper, Bart., K.C.M.G. (Chairman) presided, and among those present were General Penny, Messrs. J. S. Sellon, John I. Courtenay (Managing Director), Frederick Green, Col. F. G. Stewart, Messrs. J. W. Robinson, H. R. Muggridge, F. A. Sharpe, J. W. Skeldon, W. A. Crowley, H. E. Low, E. Strode, W. Ash and Mr. Holland Dell (Secretary), and the following report was submitted:—

The directors beg to present to the shareholders the annual report and accounts, made up to the 31st December, 1887. The gross profit for the year is £11,875 1s., derived from the trading of the company, and from royalties and receipts both at home and from the Continent. The directors have made provision for depreciation of plant, machinery, buildings and doubtful debts, by writing off the sum of £1,569 1s. 7d.

The above amount, added to the balance to the credit of profit and loss from last year, with the small item of transfer fees, makes the sum of £25,418 12s. 6d., and after deducting the expenditure of the year and the amount provided for depreciation, &c., a balance remains to the credit of this account of £10,793 6s. 11d., out of which the directors propose to place £4,000 to the credit of a reserve fund, leaving a balance of £6,793 6s. 11d. to be carried forward.

In addition to the above depreciation and reserve, a sum of £1,000 has been written off patents account, lessening the gross profit of the year by that amount, while a small increase occurs in this account through the purchase of some other patent interests which it was considered advisable to acquire, but no change in the valuation of the patent interests has been made.

Never before have so many enquiries from all parts of the country been received as during the last two or three months, or have so many negotiations been in progress in connection with the various uses to which the E.P.S. storage batteries are applicable—central station lighting, tramcar, omnibus and boat propulsion, train lighting, &c.—in each of these branches the enquiries indicate a coming activity in electrical work of a special kind, such as justifies the directors in confidently looking forward to a large increase in the demand for storage batteries during the current year.

It is much to be regretted that the electrical industry is still fettered by the Act of 1882, but the Bill of Lord Thurlow has been again introduced in the House of Lords, and there is such a concurrence of opinion in favour of an alteration of the Act, that it may be considered tolerably certain that this Session will see the much needed changes become law.

The directors are glad to state that the serious litigation on the Continent is at an end, the company having succeeded in enforcing the recognition of its rights. Arrangements have recently been completed, by which the manufacture of the E.P.S. Battery will be carried on in France, Austria, Hungary and Russia, under payment of royalties, and applications from other countries are now being considered.

In the United States the Electrical Accumulator Company is making very satisfactory progress, and the immediate prospects in the most important branches of that company's business are of a like character to those in this country.

The directors are vigilant in protecting the property of the shareholders against all assailants, and they have deemed it necessary to commence an action, for infringement of the company's patents, against the Union Electrical Power and Light Company, Limited.

The company has had its share of permanent installation work, several banks, commercial houses, and private residences in different parts of the country having been satisfactorily lighted. A large amount of temporary lighting has also been carried out.

The application of storage batteries to ship lighting has received more support during the year, and the lighting of railway trains by electricity from storage batteries is receiving considerable attention from the large railway companies, business having been done with several of the leading lines.

A new branch of business—omnibus and carriage lighting—has been initiated with good promise.

A further development of the uses of storage batteries has been made by the Exchange Telegraph Company, who have replaced 2,000 primary batteries with 210 storage cells for working their telegraphic system. These batteries are charged for about a quarter of an hour every day by means of an engine and dynamo, driven from the Hydraulic Company's mains, and after six months' trial they have been pronounced a perfect success.

In motive power moderate business has been done. Tramcar and boat propulsion are gradually developing, and among other interesting applications of E. P. S. batteries may be mentioned an electrically driven torpedo, and the experiments in connection with Mr. Eric Bruce's military balloon signalling.

Several important improvements have recently been made in the company's special manufactures. The form of E. P. S. battery, known as the "1888" type, is considered by the electrical profession as being a great improvement. In this new type the whole of the plates are joined together by metallic bands, so that the battery forms a substantial and rigid set of plates, and the original troubles of short circuiting and local action have been removed.

A gold medal for an exhibit of batteries and apparatus at the Jubilee Exhibition of the French railways was awarded to the company at Paris.

Considerable progress has been made during the year in the perfecting of the arrangements for the application of storage batteries to the public supply of electricity, a pamphlet having been issued by the company comparing the alternating current system with the storage battery system. This pamphlet has attracted much notice, and the statements made in it have been well received, and many of the opponents of the storage system have thought fit to modify their former views.

The question of distribution by continuous current transformers, which can readily be worked with storage batteries, has also been under the consideration of the directors, and the company possesses inventions which it is thought may be of value in the control of the use of storage with this new type of transformer.

Balance Sheet, year ended 31*st December*, 1887.—DR.—To capital authorised (200,000 ordinary shares of £1 each, of which there are issued and fully paid up 147,450 shares), £147,450; debentures (issued and paid), £12,065; loans by directors on security of debentures, £13,250; current accounts owing by the company, £8,407 18s. 5d.; reserve fund, £4,000; to profit and loss account (balance), £6,793 6s. 11d.; total, £191,966 5s. 4d. CR.—By patents account, £131,035 3s. 10d.; estimated value lease of premises, plant, machinery, buildings, &c., £20,041 18s. 5d.; stock at works, £16,652 19s.; current accounts due to the company, after providing for bad and doubtful debts, £19,916 3s. 6d.; cash, £4,320 0s. 7d.; total, £191,966 5s. 4d.

Profit and Loss Account, year ended 31*st December*, 1887.—DR.—To rent, taxes, &c., £570 11s. 2d.; general expenses, management, directors' fees, &c., £5,830 11s. 5d.; advertising, insurance, and travelling expenses, £2,646 11s. 4d.; debenture and other interest, discount, commissions, and compensations, £1,424 17s. 3d.; patent fees and charges, professional fees and law expenses, £1,080 12s. 5d.; abatements and allowances, £1,450 10s. 5d.; auditors' fees, £52 10s.; depreciation and reserve for doubtful debts, £1,569 1s. 7d.; reserve fund, £4,000; balance of net profit carried forward, £6,793 6s. 11d.; total, £25,418 12s. 6d. CR.—By balance from last year, £13,525 4s. 6d.; gross profit for year 1887, £11,875 1s.; transfer fees, £18 7s.; total, £25,418 12s. 6d.

The Chairman said: "In addressing some observations to you before moving the adoption of the directors' report and statement of accounts, I have first to notice that the volume of business was not as great last year as we expected, but I am glad to say that already this year a substantial increase has taken place. Our business is of a more solid character than in the past, and we direct our chief efforts to increasing the manufacturing output, as our object is not so much now to compete for large public lighting contracts. We attach, however, great importance to our installation work, and consider it to be most essential that both in the metropolis and throughout the country we should demonstrate to the public and to the electrical trade those methods and arrangements which have been adopted by our engineering department as best suited to the development and successful use of E.P.S. storage batteries as applied to electric lighting." The Chairman, having alluded to some items in the accounts above published, proceeded: The business, though unavoidably of a fluctuating nature, necessitates our keeping a staff ready and competent to deal with whatever demands may arise. Our principal branch of electrical work—the construction and working of storage batteries and their appliances—is comparatively so young an industry that we have to educate and train a staff for ourselves. I mention this in part explanation of the growth of our standing charges. There has been an increase in royalties for the past year, but I look for a much greater increase during the current year, as the result of the arrangements now completed on the Continent. We are always liable to sustain temporary damage by reason of so-called improved secondary batteries being brought to the notice of the public, and thus for a time shaking confidence and causing would-be purchasers to hesitate and delay until they see what the new thing is. The general public are obviously unable to put the true value on these statements, and it requires time and labour to disprove even the wildest assertions which are put forward. We know of other batteries, some of which in due course, I suppose, will be heralded forth as marvels of excellence; but our shareholders may rest assured that these have not escaped the attention of the directors; and these batteries, should they ever struggle into notice, will, like all the others before them, speedily disappear. The directors considered it advisable to purchase an interest in certain outside patents, and it is necessary to take out others from time to time to cover points which may suggest themselves in the course of practical work, and these outlays have increased the amount of the patents account. Among other patents taken out are two of Mr. Sellon's, who, as you are aware, is always at work for the benefit of the company, and who carries out all his experimental work at his own personal expense. These patents are for new forms and arrangements of batteries which, especially in the case of large central lighting stations, may prove of considerable future value. A brief record of the interesting and novel applications of E. P. S. batteries during the past year has been given in the directors' report, and I need not here repeat them. I would, however, draw your attention to the importance for the company of the question of central station lighting by storage batteries as against alternating current transformers, and to the warm discussions and interest these rival systems are now exciting. The pamphlet issued by this company on the subject was the result of much careful preparation, and is well worthy of perusal. Our engineer, Mr. King, continues his work in this particular direction. In motive power, the new electrical launch which made its public appearance at the Oxford and Cambridge boat race, and of which you may have read favourable notices in the electrical and other papers, embodies our latest improvements in batteries and motors, and is also fitted with special starting and reversing gear which is all quite novel. The efficiency of the motor averages 88 per cent. The best speed yet attained has been 11 miles an hour on a rather slow tide. The launch is 30 feet long, 6 feet 6 inches beam, and 3 feet 6 inches draught. At half speed the boat will go for 18 hours, and it is obvious that a noiseless boat of this size and speed will be useful for a variety of purposes, both for harbour and river work. The shareholders will note that the directors are fully alive to the necessity of keeping abreast of all inventions which may conduce to the use of storage batteries, and attention is therefore being given to continuous current transformers in connection with storage batteries. We did a good deal of temporary lighting during the Jubilee rejoicings, and among our customers are:—H.R.H. the Prince of Wales, the Duke of Leeds, Lord Rosebery, Viscount Stern, Mrs. Mackay, and many others. This company lit the Hall of the Middle Temple on the occasion of the dinner to his Royal Highness the Treasurer. Among the permanent installations referred to in the report may be mentioned the Bank of New Zealand, the Hall of the Leathersellers' Company, the extension of the lighting at Lloyd's and at the Brazilian Bank, and Barclay, Bevan, Tritton & Co.'s; also the lighting at Naylor, Benzon & Co.'s, William Joynson and Sons, in Kent; and among private residences, that of Harry Taylor, Esq., Abraham Dixon, Esq., T. A. De la Rue, Esq., G. Newnes, Esq., M.P., and others. As regards the immediate improvements in our manufactures, I must allude to the latest form of E.P.S. battery, known as the "1888" type, which has received commendation from all classes of engineers and others, as having successfully removed difficulties and objections to which some of the former types were exposed. Much credit is due to Mr. King and our electrical staff for elaborating this new type of E.P.S. battery. I am very glad to say that we have now no litigation on the Continent. Our managing director, Mr. Courtenay, has been obliged to make frequent trips to various parts of Europe, and has at last succeeded in terminating the law suits, and in making satisfactory arrangements with our adversaries, and, as I have already stated, we look for a considerable addition to our revenue from our Continental interests. Our friends in America, the Electrical Accumulator Company, are busily engaged in manufacturing batteries, and in developing the immense field for business before them, and are also taking steps to establish in the Courts the control for the Faure, Swan, Sellon, and other patents they possess of the secondary battery business in the United States, and there is no one who is better fitted by his previous training to conduct that contest to a winning result than Mr. Vail, the president of the

American company. I will now conclude by stating my conviction that at no time were the prospects more favourable to the electrical business generally, and no company is more likely to profit by its revival than we are. I beg to move the adoption of the report and accounts, and to call on Mr. Sellon to second the resolution.

Mr. Sellon, in seconding the adoption of the report, confessed that it might at first sight appear disappointing to some of them. Some months ago, having in view the work in hand and prospective orders of exceptional magnitude, the unhesitating forecast would have been in favour of a distribution at the present time of a very satisfactory dividend. What, then, were the causes for the present non-dividend position which perhaps was trying the patience of some of them? The chairman had lightly touched upon them, and he would wish to emphasise his remarks so that they should understand why they had good reason to look upon this position as only temporary, and be in no way discouraged by the unforeseen and exceptional obstacles that they had to encounter. The first deterrent cause which the chairman put before them was the appearance from time to time of the announcement of some new battery which was, of course, to eclipse all others. This announcement was generally accompanied with the most reckless statements as to greater economy, durability, and general advantage. Such statements misled the uninitiated, who, knowing that the secondary battery was one of the most important items of an installation, naturally hesitated to incur expenditure for any existing form which they were led to expect might be superseded. The stop thus mischievously put to the progress of electric lighting was incalculable, and it had been more especially marked during the past year; but this class of obstruction was, they might hope, thoroughly threshed out. They might perhaps remember that at the last meeting he took occasion to criticise a prospectus put forward at that time, by which the promise was held out to supply the necessary store of energy by delivering charged cells from house to house, and replacing them periodically. In fact, the millenium of a perfect electric light was held out to the happy customers, who were to have no trouble, and who were to be subjected only to a small payment. It was simply impossible to estimate the amount of injury done to the interests of the company by this and other similar wild and unjustifiable propositions, and he asked them whether his criticisms, which were much called in question at that time, were not fully justified. A year had passed, and not one single item of the enticing programme put forward with such a flourish of trumpets, and which for a time almost stopped their business, had been fulfilled. This was one example of the difficulties which needlessly had beset their path. Another, which in his opinion might be fraught with far more serious consequences to the public, was of a very different, and for the moment of a very important character; but it was being grappled with, and would assuredly prove but temporary — he alluded to "the alternating and the transformer craze." There was, however, one satisfactory feature even in this, for it evidenced the fact that the public had at last realised that the electric light was a necessity of civilisation. They must and they would have it, and they were now ready to avail themselves for the moment of whatever was first brought to their notice, notwithstanding its shortcomings and defects. This was a great point gained, especially as they certainly would not be content, having once realised its advantages, to do without it; and they might also feel quite sure that eventually no system which did not afford the fullest attainable security and safety could be accepted. He would take one class of work as an example. It was generally felt that sooner or later the lighting of theatres would be taken under the control of legislature. Now, was it likely that any system would be sanctioned or even tolerated which did not safeguard the public against possible extinction of the light, which, in the absence of the storage system, might occur at any moment through the most trifling accident to the machinery, to the transformers, or to overhead wires? Let them consider for a moment the probable effect of a storm upon the ramification of telegraph and telephone wires overhead, crossed and re-crossed with leads carrying powerful electric apparatus. Besides doing incalculable damage to the telegraph and telephone systems, every theatre and every public resort in London, if thus supplied, might be instantaneously plunged into darkness, and catastrophes would arise as serious, though not perhaps as painful and as harrowing, as those which have unhappily of late occurred from fires. He thought they must accept it, as being beyond dispute, that reliable continuity of the electric light was essential, and that it could only be secured by the use of storage batteries: and this being a condition indispensable both to the progress and to the success of electric lighting, their extended and ultimately universal use must be considered a certainty. This being so, they might realise what position their property, governing as it did the whole field of electrical storage, held in connection with electric lighting, which was only, they might consider, just now starting into real vitality. The distribution of electricity from centres furnished with storage batteries was now engaging the attention of their foremost electricians, and its practical accomplishment was well within view. The objection raised by some that such accumulator depots were impractical by reason of the multiplicity of the cells was absurd. Their ideas evidently did not go beyond the present baby type of cell in general use, which had met the demand up to the present time; whereas the accumulator of the future would consist of cells holding plates of dimensions and capacity hitherto unknown. The manipulation and working of these cells, of whatever size, was not only possible, but free from any difficulty with the improved forms which had been lately patented. He thought that it was hardly too much to say that from the day when the first such centre was successfully worked the first stroke in the death knell of the dangerous and alternating current and transformer system would be sounded. The finishing stroke would probably be the introduction of continuous current transformers working in conjunction with secondary batteries—a system which was beginning to attract much attention, and which in the opinion of many of their best electrical experts would carry all before it. They seemed thus to be on the eve of what he might call "the battle of the systems." He had no fear as to the result, for independently of any question of pounds, shillings and pence, the winning side must be that which proved its claim to reliability and safety, which meant only those systems which adopted storage batteries. To sum up shortly the position, they had at great cost and labour established the secondary battery on a firm basis as an indispensable and reliable factor in electrical lighting. They had both at home and abroad secured the recognition of their rights as possessors of practical and useful patents in connection with this most important branch of electrical work. In conclusion, he might say that having in view the development of electrical working going on in leaps and bounds, he thought they would agree with him that their prospects were as good as could reasonally be hoped for.

Mr. Courtenay, in reply to questions, said that their reserve fund of £4,000 was not a cash balance. It was undivided net profit—a book account which did not, of course, exist in the form of cash. If the sum was in cash they would have been very glad, for that was what the company really wanted, in order that they might compete with other companies and also cope with the large business which was coming upon them. He might take the opportunity of drawing attention to the battle of the batteries in which they were engaged. The point which he wished to allude to particularly was the durability of the E.P.S. battery. He had had lately some remarkable instances of that. When he was in Vienna last January he had the opportunity, owing to the courtesy of the representatives of the electrical staff of the Imperial Continental Gas Association, to inspect the arrangements for the lighting of the Opera House there. In that building there were 1,390 storage batteries of the E. P. S. type. The lighting was carried out to the entire satisfaction of the authorities, and carried out on the storage battery system with E. P. S. batteries. When he was there the cells were all in excellent condition. He would allude to a striking instance that came also to his knowledge. The central lighting station in Vienna belonged to the Imperial Continental Gas Association, who used in their installation two batteries of E.P.S. cells. There were 53 cells in each battery. Each cell was of the largest size containing 31 plates, so that they had 106 cells, or a total number of plates of 3,286. Those batteries had been in daily use for 15 months, yet during that period of constant use only one peroxide, or positive, plate had been renewed. That was an instance of what the E.P.S. storage plate had done under careful supervision, and he would ask them if that were not a commercial article? Had they not arrived at last at the manufacture of a commercial article and were they not justified in guaranteeing their goods at moderate rates? The shareholders would, he believed, be satisfied that a commercial stage had been attained. Questions were often asked why they spent so much money in taking out patents. When they took out patents for improvements in a battery, covering points which had occurred to their people, the money he thought was very well laid out. When they took out new patents it practically had the effect of lengthening the life of the original patents. After a lapse of many years the original patents are practically kept alive by their taking out from time to time patents which they believed would be valuable and were essential to the working of the original patents. That was the policy which they had adopted. With regard to their prospects, he would say that if only a tithe of the inquiries which now poured into the office resulted in business, their position next year would be different from what it was now.

Replying to a question, Mr. Courtenay said that the cells he referred to as having been used in Vienna were manufactured at the company's works in England, but they having now granted licences to the American Brush Company, who had sub-licensed other firms, cells would henceforth be manufactured under their patents in Austria, the company, of course, being paid a royalty.

The Chairman moved the re-appointment of Mr. Green and Mr. Sellon, the retiring directors. General Penney seconded the motion, and it was carried unanimously.

The auditors were also re-appointed.

Votes of thanks having been passed to the chairman and directors, the proceedings terminated.

The Pilsen-Joel and General Electric Lighting Company, Limited.

THE following report has been made by the committee of investigation appointed by resolution of shareholders at an extraordinary general meeting, held on March 13th, to investigate the statements contained in the directors' notice, dated March 3rd, 1888, convening such meeting, and to confer with the directors, and to report thereon, and generally upon the business of the company:—

The statement in the directors' notice, dated March 3rd, 1888, that the amount of the working capital of the company amounts to but £7,093 is taken from the last report and balance sheet issued on November 10th, 1887.

This sum of £7,093 is made up in such balance sheet of the items of :—

Cash (including £2,986 6s. 0d. consols)		£3,037 9 0
Stock, plant, stores, &c.		3,874 0 11
and the difference between		
Debtors to the company	£966 3 11	
and Creditors of the company ...	784 13 5	
		181 10 6
		£7,093 0 5

As to the above item of cash, this has practically disappeared, as the whole of the consols have been sold out and the proceeds expended by the directors, and the cash at the bankers at the commencement of this investigation was the sum of £140 17s. 6d. only.

As to the item of stock valued at £3,874 0s. 11d., this is the directors' estimate of the value of the whole of the stock, plant, and stores, &c., of the company.

As the three installations of the company alone, at which a part only of such stock, plant, stores, &c., are employed, were earning, as stated in the last balance sheet, a yearly rent of £3,485 0s. 6d. and are now stated to be producing a gross yearly income to the company of £5,000, it has been considered necessary to check this estimate of £3,874 0s. 11d. by taking stock of the whole of the existing stock, plant, stores, &c., of the company, and this has been very carefully done with the following results, which it has appeared convenient to classify as under :—

	Producing per annum.	Original cost to company.	Directors' valuation.	Present valuation.
Stock, &c., at Bethnal Green installation	£1,200 0 0	£2,158 10 11	£416 14 7	£1,482 5 7
Stock, &c., at Whetstone Park installation	1,558 0 0	4,564 0 0	900 18 0	4,500 0 0
Directors' estimate of additions since June, 1887.. ..	—	—	2,328 5 11	
Stock, &c., at Stanhope Street installation	1,156 13 4	2,116 14 3	1,193 19 0	1,819 1 9
Stock, plant, stores, &c., at Stanhope Street factory ..	—	3,413 19 6	1,022 0 0	2,093 9 0
Stock at agents and on hire ..	—	—	340 9 1	340 9 1
	£3,914 13 4	£12,653 4 8	£6,202 6 7	£10,235 5 5

There has been great difficulty in arriving at the above figures in consequence of the unsatisfactory mode in which the books of the company have been kept. There has been no stock ledger and no store ledger kept since 1884. There has been no stock book kept since 1884, except that the stock list of 1887 has been copied into a book. But the stock lists and valuations, it is stated by the secretary, have been kept separately for each of the years 1884, 1885 and 1886, and he states that such stock lists and valuations for the years 1884 and 1885 cannot be found, and they have not been produced.

It has therefore not been possible to trace or account for the stock from the year 1884, which in the balance sheet of that year was then valued by the directors at the aggregate sum of £29,876 8s. 4d.

It is presumed that the shareholders do not desire to have in this report the details (which are very intricate and elaborate and can be supplied if desired), but only the results of the investigation, and in obtaining the results which are here presented to them every care has been given to make all due allowances for wear and tear and other circumstances of depreciation.

Having regard to all such considerations the value of the now existing stock, plant, stores, &c., of the company is believed to be the above sum of £10,235 5s. 5d.

In examining the valuation of such stock made by the directors, it has been found that the stock, &c., has been most seriously under-valued. For example—a large number of Pilsen arc lamps in perfect order and in full working at installations, and each earning £20 yearly and upwards for the company, figure in the directors' valuation for 5s. 9d. each. The list price of such lamps is £12 each. The glass globes cost 10s. each. If sold by auction these lamps realise from £5 to £7 each, and the mere value of the metal if broken up and sold as scrap is 5s. 2d.

The sum of £3,874 0s. 11d. fixed by the directors as the value of the stock, was arrived at by valuation in June, 1887, and there has been since that date certain additions to such stock, but consols have been sold out by the directors in the years 1887–8, which have realised £4,769 7s. 5d.

In conference with the directors as to the mode in which this sum has been disposed of the only explanation given was that it had been spent upon the business of the company as would appear by the balance sheet to June, 1887, and by the cash book.

To enable the shareholders to determine how far this explanation is satisfactory, it has been considered necessary to prepare an analysis of the cash book, and in order that the years in which such a sum of consols was expended, may be compared by them with the years in which no consols have been expended, the analysis has been carried back to the year 1884, and accompanies this report.

The analysis is strictly compiled from the company's cash book, and the attention of the shareholders should be directed (amongst other things) to the fact that although the income received by the company from "Sales of plant, &c.," has enormously decreased, the outgoings for "rent, rates, and taxes, purchases of stock, &c.," and "wages" have varied but little comparatively. Also that in one year £1,092 11s. 1d. was expended in law costs, while the largest dividend paid in any year is £821 18s. 8d. Also that a sum of £2,500 appears in the cash book as a loan to "Ellis and Company," and in conference with the directors this is explained by them as having been lent to those gentlemen by the directors with the object of obtaining 3 or 4 per cent. interest from them.

This lending of the money of the company by the directors to individuals appears to be wholly irregular and unauthorised by the Articles of Association, and, moreover, upon investigation by the committee it is found that it was lent at an interest of 1¼ per cent. per annum only.

There also appears an item of "Contract for running new main Holborn £195 19s. 4d.," and this was found upon investigation to be a payment to another firm of electrical engineers to run electrical wires to the company's installations. This would seem to be peculiarly work proper to be done by the company's own workmen instead of employing another firm to do it at a profit. In conference with the directors, their explanation of this matter was that they thought it would be advisable, and was the best course in their opinion.

As to the statement in the directors' notice that the item of £25,190 for goodwill and patent rights should no longer be maintained at that figure, and their intention of reducing it to £527, in conference with the directors the following were the reasons given by them for this proposed reduction:—That the patents stood at cost price, and had only six or seven years to run, and that they were advised that if they earned profits it would not be advisable to pay dividends upon that amount. There was no data furnished for the reduction to £527, which appears to have been a purely arbitrary sum, and is given by the directors as their opinion of value without supplying any basis of its calculation.

DR. SUMMARY OF ANALYSIS OF CASH BOOK, FROM 1ST JULY, 1884, TO 15TH MARCH, 1888. CR.

Receipts.	1st July, 1884, to 30th June, 1885.	1st July, 1885, to 30th June, 1886.	1st July, 1886, to 30th June, 1887.	1st July, 1887, to 15th Mar., 1888.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
To cash in hand	1,247 4 1	205 4 8	487 10 7	41 14 1
„ first call	1,215 1 11	407 6 10	15 18 3	..
„ second call	3,232 10 3	..	..	..
„ transfer and probate fees ..	..	16 12 6	10 12 6	0 5 0
„ sales of plant, rentals of installations, and sundries..	10,567 4 9	6,352 0 6	4,971 13 6	3,190 10 7
„ consols sold and interest ..	..	..	1,672 5 6	3,097 1 11
„ general interest and discount	11 18 3	19 3 2	7 11 3	..
„ bank—deposit withdrawn ..	..	2,500 0 0	..	..
„ directors' fees returned ..	..	..	..	200 0 0
„ Ellis & Co.—loan repaid ..	..	2,500 0 0	..	..
	£16,273 19 3	£12,000 7 8	£7,165 11 7	£6,529 11 7

Payments.	1st July, 1884, to 30th June, 1885.	1st July, 1885, to 30th June, 1886.	1st July, 1886, to 30th June, 1887.	1st July, 1887, to 15th Mar., 1888.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
By factory and installations—wages, salaries, rents, rates and taxes, &c. ..	9,041 10 9	4,940 12 5	4,730 18 9	5,354 17 1
„ general expenses—directors' and auditors' fees, patent duties, advertising, &c...	915 17 9	464 0 0	464 14 7	416 8 4
	..	..	12 15 6	..
„ law costs	892 11 1	108 4 8	93 10 0	10 10 0
„ dividends	..	..	821 18 8	410 19 4
„ investment in consols ..	..	3,500 0 0	1,000 0 0	..
„ deposit with bankers ..	..	2,500 0 0	..	..
„ surrender of fully paid shares..	315 0 0	..	..	..
„ return—calls overpaid ..	3 15 0	..	..	..
„ „ apprentices' fee ..	50 0 0	..	..	..
„ Roopers & Whately (solicitors' costs)	200 0 0	..	..	..
„ Union Electric Light Co. ..	2,000 0 0	..	..	..
„ H. Joel	150 0 0	..	..	..
„ Ellis & Co.—loan	2,500 0 0	..	..	..
„ contract for running new cable, Holborn	..	..	..	195 19 4
„ balance—cash in hand ..	205 4 8	487 10 7	41 14 1	140 17 6
	£16,273 19 3	£12,000 7 8	£7,165 11 7	£6,529 11 7

1888.		£ s. d.	£ s. d.
31st March.	Debts due by company (including Hornsby & Son)	..	3,090 0 0
	Rentals due to company, Lady-Day	1,280 0 0	
	Book debts (including rentals in arrears)	700 0 0	
		£1,980 0 0	
	Cash now at bank	90 0 0	
			2,070 0 0
			£1,020 0 0

Dated this 12*th* day of *April*, 1888.

(Signed) { ANDREW HUTTON.
JAMES FYFE.

In proposing this enormous reduction (as a matter of principle and apart altogther from the amount of it) the directors have merely considered the fact that the patents are running out, and have entirely ignored the goodwill, overlooking that under good management the value of the goodwill of the business should increase in at least the amount of the diminution of the value of the patents.

It is obvious that the mere goodwill of a business which is said to earn £5,000 per annum from its installations must be worth immensely more than £527.

As to the general business of the company, under the existing system of management it has not been, and it is not possible that it should be worked with either efficiency or economy.

There is no proper system of check or control of stores issued. The books of the company are not properly kept, and some of them are even now not posted since January last. The company have obtained many orders for lighting and have left them unexecuted for several months, in some cases actually going to the expense of running the wires without fixing any lamps. There is no reserve of power at the Stanhope Street installation for any further business, and at Whetstone Park installation there is no reserve boiler power, and the whole installation is at the risk of a breakdown from the leakage of a single tube.

The sum of £4,769 7s. 5d. has been realised from the sale of consols by the directors, and spent by them during the period in which two of the three directors were disqualified and their office vacant without any improvement in the finanical position of the company, and but for the repayment by them since the last meeting of £200, which they had improperly paid themselves for directors' fees, the company would have had absolutely no money at the bank at the commencement of this investigation.

In the now existing condition of the company, it is, of course, necessary that capital should be obtained to enable it to carry on its business properly or at all. The business, if properly managed, should be a successful and profitable one, as the system of lighting is exceedingly popular with all its customers, the number of whom might be almost indefinitely increased.

It is regretted that it has not been possible to submit this report to the shareholders at an earlier date, but the committee have not been facilitated by the directors or the secretary in their investigation, and from the 29th March to the 4th April instant the offices of the company were closed, the secretary absent, and the books locked up, although he had been distinctly informed that the committee desired to have access to them, and continue the investigation during that period.

During that absence of the secretary and manager, one of the installations had to discontinue its lighting of a public house at 9.30 in the evening because at the Stanhope Street Factory there were no coals.

The Eastern Extension, Australasia and China Telegraph Company, Limited.

THE report of the directors for the half-year ended December 31st, 1887, states that the gross receipts, inclusive of Government subsidies, have amounted during that period to £232,660 0s. 11d., against £216,956 2s. 8d. for the corresponding half-year of 1886.

The working and other expenses, including £22,730 1s. 6d. for cost of repairs to cables and expenses of ships, absorb £69,570 16s. 5d., against £80,066 10s. 11d. for the corresponding period of 1886, leaving a balance of £163,089 4s. 6d. From this is deducted £3,605 3s. 10d. for income-tax and £41,595 for interest on debentures and contributions to sinking funds, leaving £117,889 0s. 8d. as the net profit for the half-year, which, with £35,162 4s. 9d. brought forward from the previous half-year, shows an available balance of £153,051 5s. 5d.

One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 3s. per share, or 1½ per cent., making a total distribution of 6½ per cent. for the year 1887. The balance of £53,051 5s. 5d. has been carried to the general reserve fund, which, after being debited with the cost of the further partial renewal of the Singapore-Saigon and Penang-Rangoon cables, amounting to £22,758 15s., now stands at £620,095 13s. 6d.

In pursuance of the conditions upon which the issue was made 113 of the company's 5 per cent. debentures of 1880 were drawn by lot on the 16th ult. for payment at par on May 1st prox.; 276 of the company's 5 per cent. Australian Government subsidy debentures were also drawn on the 9th inst. for payment at par on July 1st next.

The company's maintenance ships have been employed on various cable repairs during the half-year, but no interruptions of a serious nature have occurred.

The Government of New Zealand having declined to ask the Parliament for sanction to renew the New Zealand cable subsidy, the tariff for ordinary intercolonial telegrams was raised on January 1st last from 6s. to 8s. 6d. per 10 words. A cheap rate has, however, been granted for news telegrams between New Zealand and Australia, which appears to be generally appreciated.

A further Intercolonial Conference was held at Sydney in January, when the proposals submitted by the company for reduced tariffs between Europe and the Australasian Colonies, based upon a colonial guarantee or subsidy, were discussed, and resolutions were come to that consideration should be given to the said proposals by the various colonies, and that each colony should contribute towards the existing and future cable subsidies in proportion to population.

Your directors have to record with deep regret the sudden death on November 16th last of their esteemed colleague Sir William McArthur, K.C.M.G., who had been connected with the company since its formation.

Under the powers given to them by the articles of association they have elected Mr. John Denison Pender to fill the vacancy thus occasioned.

Montevidean and Brazilian Telegraph Company, Limited.

THE ordinary general meeting of this company was held at the offices, 2, Tokenhouse Buildings, E.C., on Monday, Dr. Charles Cameron, M.P., the Chairman presiding. The following report of the directors was submitted and adopted:—The percentage of gross revenue receivable from the Western and Brazilian Company shows a slight increase, being £2,508 9s. 1d., as compared with £2,370 6s. 5d., in 1886. The directors had hoped from the improved condition of trade with South America, that they would have been able to report a more favourable result to the shareholders. The directors are glad to observe that so far as can be judged from the published returns of the Western and Brazilian Telegraph Company, there appears some prospect of a greater improvement in the traffic during the current year. The shareholders will remember that the debentures issued in 1876 were made redeemable on the 1st of July, 1896. There being a balance of £10,280 still unredeemed, it will be necessary to set aside annually a larger sum for the purpose of redemption than hitherto, and the directors therefore propose to appropriate £1,000 for that purpose for the year 1887, which leaves a balance of £474 7s. 11d. available for division. The directors recommend the payment of a dividend at the rate of 1s. per share on the preference shares of the company, which will absorb £415 14s., leaving a balance of £58 13s. 11d. to be carried forward to next account. The directors regret to inform the shareholders that Sir Thomas Gore Browne, K.C.M.G., C.B., who so long occupied the position of chairman of the company, died in the month of April, 1887. Mr. James Joicey, M.P. (whose interest in the company as a shareholder is larger than that of any other gentleman), was appointed a director of the company, to fill the vacancy left by the death of Sir Thomas Gore Browne.

Dr. Charles Cameron, M.P., the retiring director, and the auditor, Mr. W. S. Ogle, were re-elected, and the meeting terminated.

The Indo-European Telegraph Company, Limited.

THE directors' report for 1887 states that the company's revenue from all sources for 1887 amounted to £104,290 18s. 3d., as compared with £104,583 0s. 7d. for 1886, showing a decrease of £292 2s. 4d.

The expenses were: on commercial and general account, £26,274 7s. 4d.; on maintenance account, £22,346 7s. 11d., including £256 5s. 9d. paid to the Russian Government; total, £48,620 15s. 3d., as against £50,773 7s. 8d., a decrease of £2,152 12s. 5d.

Deducting the above expenses, taking credit for £1,093 6s. 7d. brought over from 1886, and debiting income tax, there remains the sum of £55,194 15s. 1d.

From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £34,569 15s. 1d.

The directors now propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year, carrying forward £2,694 15s. 1d. to the credit of 1888.

The falling off in the revenues derived from Indian messages remarked upon in 1886, has continued during 1887, but fortunately has been made up by other sources of traffic.

Last November the company applied the duplex system to work either of the two circuits between London and Emden; the arrangement has given very satisfactory results, and the cost of its introduction is included under the head of maintenance expenses.

The St. James's and Pall Mall Electric Light Company, Limited.—The prospectus of this company is in circulation. The capital is £100,000, £99,900 being in ordinary shares of £5, and the balance in founders' shares of £1, the latter being entitled to one-half the profits after payment of 7 per cent. on the ordinary capital. The company proposes to establish a central station for the supply of the electric light to an area which includes Pall Mall, St. James's Street, Piccadilly, and Waterloo Place. A freehold site has been acquired at a cost of £9,500, and a provisional contract has been entered into with Messrs. Latimer Clark, Muirhead & Company, Limited, for a supply of the necessary plant to establish a first installation of 10,000 lamps at an estimated cost of £18,500. No patents are to be acquired. All the founders' shares are to be issued to the promoters of the company, and there are now offered for subscription 10,000 of the ordinary shares.

The Great Northern Telegraph Company of Copenhagen.—The accounts for 1887 show that the receipts less loss on exchange were £250,783, the total including £31,586 brought forward, interest and sundries being £310,802. After providing for expenses, debenture interest, and amortisation of debentures, the additional dividend at the rate of 2½ per cent. takes £37,500, the interim dividend having absorbed £75,000. An addition of £55,555 is to be made to the reserve and renewal fund, £41,921 being carried over.

Anglo-American Telegraph Company, Limited.—It has been resolved to declare an interim dividend for the quarter ending March 31st, 1888, of 5s. per cent. on the ordinary stock and 10s. per cent. on the preferred stock, less income tax, payable on the 1st May to the stockholders registered on the books of the company on April 10th, 1888.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 13th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,787.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending April 13th amounted to £4,649.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, April 12th, Mr. E. GRAVES, President, in the chair. A paper was read by Mr. R. E. CROMPTON, member, on "Central Station Lighting—Transformers *v.* Accumulators."

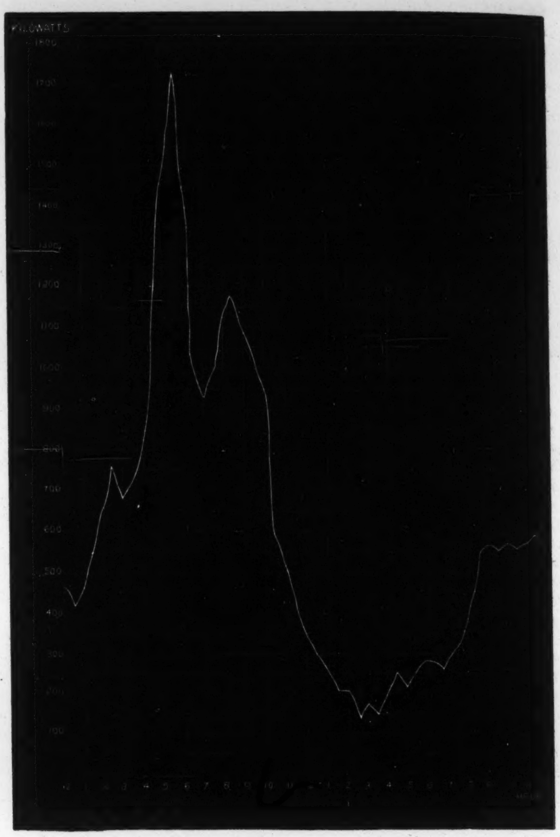
The present paper is the outcome of the discussion which took place on Messrs. Kapp's and Mackenzie's papers on transformers, recently read before this society. I was asked to give facts and figures in support of the statement I then made, that I believed the distribution of electricity by transformers offered no special advantages over other methods, particularly over distribution by means of accumulators used as transformers.

However, after compiling the statement of facts and figures necessary for my purpose, I found that I had undertaken a task of a much heavier nature than I originally intended; and I must apologise for the present paper having a much wider scope than its title would warrant.

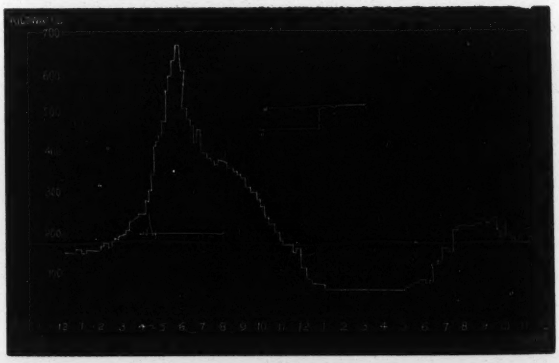
In fact, I find it necessary to commence by discussing some of the conditions of the supply of electricity from electric stations which are common to all systems of distribution, and about which little or nothing has hitherto been written or said. In England central station lighting has been such an affair of yesterday that it is hardly to be wondered that what little knowledge exists on the subject should be confined to the few who have lighting stations under their immediate charge; and when we look to the Continent, or to America, to supplement this meagre stock of knowledge, we find the conditions of demand for light differ from those of a large English town, such as London, so that they do not much help us in our investigation. However, during the past few years I have done my best to make myself acquainted with the main facts which appear likely to govern the future commercial success of such undertakings.

I must at once divide the schemes for electric supply into two classes—first, those confessedly carried out in a temporary manner, and for the purpose of popularising the electric light, and inspiring the confidence of the public in supply companies as a form of investment; and, secondly, those intended to be of as permanent a nature as the gas supply, with which they come into competition. I think to the first class we must relegate such systems of supply as those at Brighton, Eastbourne, the present supply from the Grosvenor Gallery—in fact, all those which distribute by means of overhead wires, picking their customers here and there, and which, although they have served a very useful turn in familiarising the public with the use of the electric light, cannot be considered as in any sense fitted to develop themselves into a complete system of supply when the time arrives that more than half the houses may be expected to take the light.

In order to get an adequate idea of the nature of the demand, or what I call the load diagram of a system of supply, we cannot do better than refer to the diagrams of a similar nature taken by the gas companies. Having recently had the advantage of carrying out electric supply stations for several gas companies, I have had access to such load diagrams for gas lighting, and from these and from the experience already obtained of electric supply in London I have constructed a load diagram which I believe will be found a fairly representative one for an ordinary London residential district, consisting partly of private houses, partly of shops, with the usual sprinkling of hotels and public buildings. No doubt a district containing a very large number of theatres would have a somewhat different diagram, but not differing so much as to materially affect the arguments that I am about to found on these load diagrams. Through the kindness of Dr. Fleming I am able to lay before you several load diagrams obtained from lighting stations in America, which you see coincide very fairly with the one I have prepared for London. We learn from these load diagrams—first, that the average daily outputs in units throughout the year is about three and a half times the maximum load in kilowatts; in other words, that a station having a plant equal to the supply of 600 kilowatts—that is to say, 10,000 lamps, of 16 candle-power, each simultaneously alight—could only calculate on selling an average quantity of 2,100 units per day. This fact, which has such an important bearing on the possible



BOSTON



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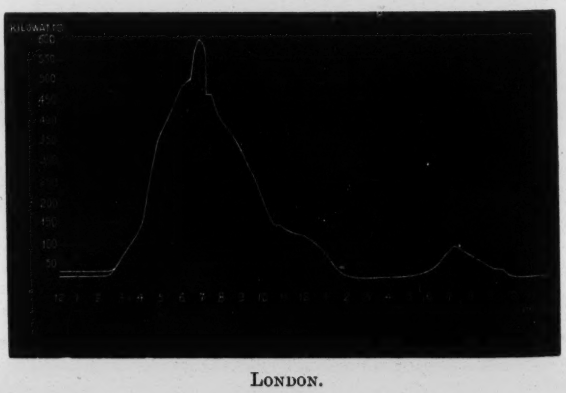


LONDON.

profits to be obtained from a station of a given size, appears to have been completely ignored by the writer of an article on central stations in *Industries*, dated December 2nd, 1887, who estimates that a plant of this size would be able to supply daily 3,600 Board of Trade units, which is 73 per cent. in excess of the figure I have given above. The next point we have to note, common to all systems of distribution, is the extent of underground mains necessary to distribute a given supply of electricity, and the probable cost of such mains when laid underneath the footways of our streets. Starting once more on the above quoted 1,000-light plant basis, I find, from careful note of the amount of electricity used by various classes of houses, that in order to sell an average of 2,100 units per day our distributing mains must reach not less than 1,000 houses. We may take the average width of the London house at 10 yards; to this we must add 50 per cent., on the supposition that only two houses out of three will take the light for some time to come; and on to this we must again add 30 per cent. for such proportions of the roads, such as crossings, dead walls, &c., traversed by the mains which do not front houses taking the light. We thus find that every house requires 20 yards of distributing main; or to distribute the daily average supply of 2,100 units, 20,000 yards of main. In addition to these distributing mains we must contemplate the probability of the generating station being placed at a distance of 2,000 yards from the centre of the district supplied, so that in all we have to provide 22,000 yards of mains of the two classes of mains. For convenience of nomenclature I call those mains which form the primary wire to the transformers, or carry the charging current to the accumulators, "charging mains;" and those from the transformers to the houses, or from the accumulators to the houses, "distributing mains." Next, as to the cost of these mains. I have prepared two tables, which show how wide of the mark is the popular idea that the cost of the mains is greatly influenced by the cost of the copper conductors themselves. I have stated at this Institution that much nonsense has been talked on the subject of the cost of copper; by this I did not intend to be disrespectful to any particular speaker, but to point out in strong language that the habit of basing estimates of distribution on the cost of copper (with but a small percentage added for insulation and laying) was one to be avoided, as it has led to erroneous conclusions, on which have been based arguments far too favourable to systems using currents of high E.M.F.

No doubt this habit of considering the cost of copper as such an important element in the calculation has arisen from the fact that, although this question of electrical distribution has been for years under discussion, and has had volumes written about it, yet our experience in laying and repairing such conductors has been until quite recently almost nil. The tables now before you are based on the little experience that I have gained during the last three years, and I trust they may be of some service to the members of the Institution. Many of the figures are the actual prices paid out on executed contracts, and the other ones are calculated from them; so that it is quite certain that the figures quoted in the table are not far wide of the mark. You will notice that, apart from the price of the copper itself, the additions we have had to make for the insulation troughing, cost of laying, providing and fixing surface boxes, digging and guarding the trenches, taking up and replacing the flagging and wood pavements, are almost a constant quantity depending only on the length of the roadway that is disturbed, and, consequently, when considered in relation to the cost of copper itself, are at a maximum when the section of the copper is small and decrease rapidly as the section augments.

Table No. 1 is for laying copper in the form of insulated cables in the old and well-tried way. Table No. 2 is for a form of main which I have successfully adopted during the past year, and which consists of a bare copper conductor, supported and insulated in concrete subways or culverts by porcelain insulators. I am not at present submitting the latter system for your criticism. In some respects it is not yet perfect; but I mention it as I am employing it to a considerable extent myself, and believe that it will prove a very valuable form of conductor for whatever system of distribution is used. The completed main consists of such very durable materials, and the facilities for repairs and renewals, or for increase in the section of the conductor, are so great, that the annual charge for the upkeep and depreciation of these mains is not likely to exceed 25 per cent. of that of the older form of cables insulated with the continuous covering, whatever material may be employed for that covering.

With these considerations of the load diagrams, the extent of distributing system, and the cost of the mains before us, we can now proceed to compare the merits of distributing the electricity by two systems—the first being by alternating currents of high E.M.F., transformed to currents of low E.M.F., suitable to the glow and arc lamps used by the consumers, and which I hereafter

TABLE I.

Cost of Laying 100 Yards of Double Conductor underneath the Footway of a London Street.

	Single. No. 16.	$\frac{7}{16}$	$\frac{19}{15}$	$\frac{19}{12}$	$\frac{19}{10}$	$\frac{37}{10}$	Two Sets. $\frac{37}{10}$	Four Sets. $\frac{37}{10}$	Six Sets. $\frac{37}{10}$
Area, square inch	·0032	·0225	·0773	·1613	0·25	0·5	1·0	2·0	3·0
Area, square millimètre	2·08	14·6	50	104	161·25	322	645	1,290	1,935
Weight per 100 yards run ... lbs.	7½	53½	183¼	392	576	1,153	2,306	4,612	6,918
Cost of Copper at 7¾d.	£0 4 10	1 14 6	5 18 0	12 13 0	18 15 0	37 5 0	74 10 0	149 0 0	224 0 0
Cost of Insulation	1 3 2	4 8 6	11 2 0	24 17 0	35 17 0	70 15 0	141 10 0	283 0 0	424 0 0
Total cost of Cables	1 8 0	6 3 0	17 0 0	37 10 0	54 12 0	108 0 0	216 0 0	432 0 0	648 0 0
Casing, Bitumen, and Cement ...	5 3 0	5 5 0	8 0 0	12 10 0	12 10 0	16 0 0	22 0 0	40 0 0	55 0 0
Labour, Laying	3 0 0	4 0 0	5 0 0	5 0 0	6 0 0	10 0 0	18 0 0	35 0 0	50 0 0
Trenching and Repairing	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	30 0 0	35 0 0
Surface Boxes and Connection ...	5 0 0	7 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Engineer and Superintendent ...	3 0 0	4 0 0	5 0 0	5 0 0	6 0 0	10 0 0	10 0 0	20 0 0	25 0 0
Total	£42 11 0	51 8 0	70 0 0	95 0 0	114 2 0	179 0 0	301 0 0	567 0 0	823 0 0
Add extra if Copper, at 9½d. ...	0 1 1	0 8 0	1 7 0	2 17 0	3 5 0	8 10 0	17 0 0	34 0 0	51 0 0
	42 12 1	51 16 0	71 7 0	97 17 0	117 7 0	187 10 0	318 0 0	601 0 0	874 0 0
Cost of Copper per lb., laid complete	5 13 6	0 19 4	0 7 9	0 5 0	0 4 1	0 3 3½	0 2 8¾	0 2 7¼	0 2 6¼
Current in ampères	1·2	8·1	28	58	90	180	360	720	1,080
Cost per ampère	35 10 0	6 8 0	2 10 6	1 13 9	1 6 0	1 1 0	0 17 6	0 16 8	0 16 1

TABLE II.

Cost of Laying 100 Yards of Double Conductor of Bare Copper carried on Insulators in a Culvert.

Area in square inches	0·25	0·5	1·0	2·0	2·55	3·00
Area in square millimetres	161·25	322·5	645	1290	1645	1935
Weight of copper in lbs. per 100 yards	576	1153	2306	4612	6125	6918
Cost of copper at 7¾d. per lb.	£18 15 0	37 5 0	74 10 0	149 0 0	190 0 0	224 0 0
Laying	9 0 0	9 12 0	9 12 0	9 15 0	9 15 0	10 0 0
Insulators	0 4 6	0 4 6	0 4 6	0 4 6	0 4 6	0 4 6
6 surface boxes and connections	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Culvert, 18 inches × 12 inches, for two lines conductor, in brickwork and cement, replacing pavement ...	53 8 0	53 8 0	53 8 0	53 8 0	53 8 0	53 8 0
Engineers and superintendence	6 0 0	10 0 0	10 0 0	10 0 0	10 0 0	15 0 0
Total	£97 7 6	120 9 6	157 14 6	232 7 6	263 7 6	312 12 6
Extra for copper at 9½d. per lb	3 5 0	8 10 0	17 0 0	34 0 0	43 10 0	51 0 0
Total	£100 12 6	128 19 6	174 14 6	266 7 6	306 7 6	363 12 6
Cost of copper per lb. laid complete	42d.	27d.	18·2d.	13·8d.	12d.	12·6d.
Current in ampères	90	180	360	720	910	1080
Cost per ampère	1 2 3	0 14 5	0 9 8	0 7 5	0 6 9	0 6 8½

call the A.T. system; and second, the supply by means of direct currents of medium E.M.F. used to charge accumulators arranged in series, the current being taken off the accumulators at the lower E.M.F. required for the lamps, and which I hereafter call the B.T. system.

All modern systems of distribution aim at the reduction of the first cost of the distributing plant—that is, of the charging and distributing mains, and all appliances belonging to them, such as transformers, regulating devices, street surface boxes, house connections, &c., providing that such reductions shall not be at the expense of the efficiency of the system. It is difficult to fix an exact percentage of the loss allowable in the distributing plant, as so much depends on the length of the working hours, but I take it for granted that in no case must this loss exceed 10 per cent. I further take it for granted that the extreme variation allowable in the E.M.F. in the distributing mains must not exceed 4 per cent. So much has recently been written on the A.T. system that I will not lengthen this paper by describing it further than by stating that for purposes of my comparison I take the system as generally described by Mr. Kapp in his paper on transformers; or by Mr. Mackenzie, in his paper on transformers; and in an article in *Industries*, dated December 2nd, 1887. for which I believe Mr. Kapp is responsible, and which gives very complete data on the first cost of an installation for 10,000 60-watt lamps, burnt simultaneously. On the other hand it is necessary for me here to briefly explain the B.T. system, which I propose to compare with it.

At Vienna the arrangements proposed by M. Monnier, and successfully carried out by myself and others, consist of charging from a central station groups of batteries of accumulators arranged in series. Each group of accumulators consists of 52 cells, giving the 100 volts required for the lamps, with a comfortable margin. The total E.M.F. required to charge the four groups of batteries in series varies from 430 volts, at the time the batteries are giving off work, to 480 volts, for the short time during which the charge is being completed. This includes the loss in the mains, generating stations being situated 1,400 yards from the distributing station. During five hours of lighting about two-thirds of the current comes direct from the dynamos; but during this time for short periods the demand of current often increases to such an extent that these proportions may be reversed, and the batteries supply two-thirds of the total. As this system has now been in use for upwards of nine months without any hitch or trouble whatever in connection with the electrical work, we may consider it proved there is no danger or difficulty in using currents of such high E.M.F. as 480 volts connected permanently to the distributing mains. The system may, of course, be united with three or two groups only in series. An example of the last is the central station belonging to the Lemans Gas Company.

I now propose to commence my comparison of the two systems from four points of view.

1. As to trustworthiness, steadiness, and quality of the lighting;
2. As to first cost of the plant; and
3. As to working cost and maintenance;
4. As to the probable output, and hence maximum income, that can be safely obtained from the sale of electricity in each case.

I think it will be allowed that the commercial success of an electric light undertaking depends on these four points. I do not propose to dwell much on the first point. It is generally admitted that a system which uses storage must be superior to a system in which the continuity of the lighting depends entirely in moving machinery. There are many reasons why I should not make invidious comparisons on these points between existing systems. No one is prepared to dispute the facts that the A.T. systems hitherto installed have been remarkable for frequent interruptions in the lighting, whereas the reverse has been the case with the B.T. system. It remains for us to consider whether the undoubted great advantages which the B.T. system possesses in this respect is not purchased too dearly; and this matter will occupy the remainder of my paper. The comparison I now make is for a system of electrical supply for London for 10,000 60-watt lamps, or their equivalent, simultaneously alight at hours of maximum demand.

1. By alternating currents reduced from 2,000 volts to 60 volts by transformers.
2. By direct currents reduced from 440 volts to 110 volts by accumulators used as transformers.

Cost of Generating Station.—For the A.T. system I adopt the figures given by the writer in *Industries*, on page 600, of the 2nd December, 1887. He therein proposes to provide for the 10,000-lamp plant dynamo power including reserve equal to 865 kilowatts, and he fixes the price of those as £5,540. As regards motive power, I do not propose to take advantage of the writer's far too liberal estimate of its cost at £12 per I.H.P., but take it at the lower figure of £8 12s. per I.H.P., thus reducing the cost to £12,500. I have estimated the cost of the building, chimney stack, water tanks, connections for water, drains, all measuring instruments and other accessories, at £11,000, thus bringing the total cost of the generating station of the A.T. system to £29,040. For the B.T. system I propose to provide plant of exactly similar type to that I have already supplied to Vienna. As I have said before, I propose that the dynamos should supply two-thirds of the maximum net output of 600 kilowatts. We therefore require about 448 kilowatts at the terminals of the accumulators; or, adding an 8¼ per cent. loss in the charging mains, 490 kilowatts in the generating station; 20 per cent. of reserve power will bring this up to 600 kilowatts, equal to 1,000 I.H.P. Such a plant may be conveniently divided into six sets of combined engines and dynamos, each of 100 kilowatts. Adopting the figure given above, viz., £8 12s. per I.H.P., as the cost of the motive power, and that given by the writer in *Industries* at £8 per kilowatt, or £4,800 for the six sets of dynamos, and estimating that the cost of the building and other accessories, as before detailed, for the A.T. system will, in this case, be only £8,000, we find that £21,500 is the cost of the generating station for the B.T. system.

The cost of the alternating transformers is a very difficult matter to arrive at. The Grosvenor Gallery Company, I believe, with few exceptions, supplies every consumer with his own transformer; but Mr. Kapp, in his recent paper, proposes to lay down a network of mains of much the same character as I use for the B.T. system, and to supply this network by a certain number of larger transformers, placed at frequent intervals in the network. It is difficult to see how any saving can be made by this arrangement. It will be noticed that, although it reduces the number of transformers, it introduces a new element of expense and difficulty, and that is, the providing of places to fix these large transformers. It may be that such places can easily be found, but my experience has been otherwise. It is not easy to find a place for any piece of machinery of a size between that which can conveniently be got into a surface-box placed in the pavement not exceeding one foot in depth by two feet square and a sub-station of the size I require for my battery transformers. In most cases there is no space either under the footways or under the street itself to form a water-tight chamber of sufficient cubic capacity for the purpose. Another difficulty and cause of additional expense which I think would tend to counterbalance any saving from the decreased number of transformers would be that the charging mains laid *to* the transformers, and the distributing mains *away* from the transformers, would have to be laid in the same trench or culvert, and this would be no small source of danger to those at work connecting houses on to the distributing mains. As I have not been able to obtain any reliable data on this modified system of Mr. Kapp's, I am obliged for the present to return to the system using one transformer for every two houses, and I think, for the reasons I have given above, the advocates of the A.T. system will not be able to make any great saving by adopting Mr. Kapp's suggestions.

Accumulators, to be used as transformers, must be of sufficient capacity to supply 200 kilowatts per hour for the hours during which the demand exceeds the 400 kilowatts supplied by the dynamos. The load curves show that this period of maximum supply varies from about two hours in summer to four hours in winter. If I provide four groups of accumulators, each of which has a total capacity of 259 kilowatts, or 1,000 kilowatts for the four, I provide for five hours of extreme demand, which is a condition of things extremely unlikely to occur, even in times of a fog. For it must be noted that the demand for light during a fog in the daytime (in a district partly residential and partly supplying shops) is of a far lighter nature than the demand from the same district during the ordinary hours of maximum lighting; the reason being that, during the hours of maximum lighting, not only the lamps in the basement, passages, and a certain portion of the dwelling-rooms require to be simultaneously alight, but all upstair passages and a certain proportion of the bed-rooms also require light. This is

TABLE III.

Cost of 10,000-*Light, or* 600-*Kilowatt, Plant.*

A.T.—Alternating Transformer Distribution.	£
Generating station, buildings, chimney shaft, water tanks, and general fittings	11,000
Dynamos and exciters—865 kilowatts, including spare sets, divided as convenient	5,540
Motive power, *i.e.*, engines, boilers, steam and feed connections, belts, &c., at £8 12s. per I.H.P.	12,470
500 transformers, *i.e.*, one to every pair of houses, at £15 each	7,500
2,000 yards primary or charging main, exterior to area of supply, at £308 per 100 yards	6,160
20,000 yards distributing main, 50 m/m. sectional area, at £91 7s. (*see* Table 1)	14,270
Regulating gear	500
	£57,440

B.T.—Accumulator Transformer Distribution.	£
Generating station, buildings, chimney stack, water tanks, and general fittings	8,000
Dynamos—600 kilowatts, in six sets of 100 kilowatts each	4,800
Motive power, *i.e.*, engines, boilers, steam and feed connections, &c., at £8 12s. per I.H.P.	8,600
4 groups of accumulators, in all 240 cells, in series, at £40 per cell, including stands	9,600
2,000 yards charging main, at £306 17s. 6d. per 100 yards (*see* Table 2)	6,137
20,000 yards distributing main, 161·25 m/m. sectional area, at £100 12s. 6d. (*see* Table 2)	20,125
Regulating gear...	2,500
	£59,762

not the case during a fog; only the basement, lower passages, and living rooms take the light, and these to not nearly the same extent as they do in the evening. In order to meet a case of possible interruptions to the charging current, which might take place at the time of maximum demand, we require these accumulators to be capable of being discharged without damage to themselves, and at a fair rate of efficiency, at a rate not less than 650 kilowatts. It is this latter requirement that has so long delayed the introduction of accumulators as transformers. Up to a recent date far too much attention has been paid to the capacity, and too little to the rate of possible maximum discharge. This state of things has lately been remedied, and I am told there are several makers of accumulators who can supply them to fulfil the above-mentioned conditions, and at the reasonable price named by me in my estimate. It must be remembered that such accidental stoppages of the lighting current as are likely to take place would not probably last for more than a few minutes—that is to say, if due provision has been made for spare machinery, and if the arrangements for working the machines parallel and interchangeable have been properly carried out. Time will not permit me in the course of this paper to describe fully the switch board and regulating arrangements necessary for the B.T. system. These require to be so arranged that the loss due to the difference of E.M.F. between the charge and discharge of the batteries may be as small as possible. It is quite possible to work the batteries parallel to the charging current during the hours of maximum demand with little or no loss from this cause, the loss being confined to the hours when the batteries are being finally filled up before the engines are stopped. The sub-stations, which contain the accumulator transformers, can in almost every case be placed on "mews" property, and I have ascertained from accurate enquiry that there is no difficulty in obtaining accommodation for them in such property, with but few exceptions, within 300 yards' radius of the houses to be supplied. In each case the sub-station consists of a battery room and living room for the man in charge. The plant in each sub-station consists of the batteries themselves, the regulating appliances above mentioned, volt meters and district meters as may be thought necessary.

Distribution.—In the case of the A.T. system the charging mains, as far as they lie within the area of supply, are in reality the distributing mains; in other words we require 20,000 yards of distributing mains to reach the houses. I am informed that the section usually employed for the distributing mains of these 2,000-volt circuits, when the transformers are placed in parallel, is 50 millimetres cross section, or 19 strand, No. 15 B.W.G. From Table No. 1 you will see that this costs £71 7s. per 100 yards. I have not worked out the cost of so small a section laid on my own plan in the culverts, but it would certainly not be less than £96 per 100 yards. However, adopting the lower figure, the distributing main will cost £14,270. The writer in *Industries* says that 720 kilowatts will have to be generated at the generating station for transmission to the area of supply; dividing this by 2,000 volts, we get 360 ampères as the current in the charging main. Adopting Professor Forbes's tables for calculating the section of the conductor, we find that it ought to be about 645 millimetres, and if laid in the cable form, as in Table 1, but without surface boxes, would cost about £308 per 100 yards, or in all £6,160. It will be asked why I do not give to these charging mains the advantage of the somewhat lower cost of laying them as bare copper, as in Table 2, but I do not think it would be safe to leave conductors carrying currents at 2,000 volts thus unprotected in the culverts, as the risk to workmen employed on the district system would be too great, to which must be added the great risk to the consumers, of making an accidental contact from the charging to the distributing mains. I should here remark that the very confident tone adopted by many supporters of the A.T. system rests on very slender foundations; they appear to forget that the great success obtained in America has been with overhead wires used as the primary or charging mains. We all know what a high degree of insulation is possible with overhead wires; we also know that extreme difficulty has been met with in America in all attempts to obtain sufficient insulation for wires carrying currents of high E.M.F. when laid underground. As a matter of fact, failure has been the rule, and success the exception. I believe that the difficulties of the A.T. system will commence when the contractors have to guarantee a perfect insulation with underground cables carrying currents at an E.M.F. of 2,000 volts. Let those who think otherwise read Prof. Elihu Thomson's remarks at the recent electric light convention in America. He used the following words: "Distribution of current to groups of incandescent lamps, arc light, or other high potential lines should always be undertaken with great care, and it is thought that such work should only be undertaken when exceptionally favourable conditions for avoiding accidental leakages exist, especially should the potential of the line at the dynamo exceed 1,500 volts, or an amount which would sustain 30 arc lamps in series. One of the important elements of safety in such installations is simplicity and ease of inspection of the wiring, and no concealed wires should be used in them." Again he says, "for house to house and general incandescent lighting, where the distances from the stations are not too great, the direct low potential systems possess most of the advantages, the difficulties of leakage from the defective insulation being of course at a minimum; but where the distances are so great as to make the required outlay for copper in the conductors practically prohibit the extension of the system, a transformer or converter system, if of good design and economy, may be made to yield excellent results." Now the writer of these words is one of the greatest authorities on electric lighting matters in America, and a strong supporter of the A.T. system. I think, therefore, that I have not dwelt too strongly on the grave difficulties likely to be encountered by those who so glibly talk of laying underground charging mains, carrying currents at 2,000 volts potential, and I think that in all probability the additional precautions that will have to be taken to avoid failure of the insulation will be so expensive as to bring the total cost of the 22,000 yards up to practically the same sum as is required for the 2,000 yards of charging main, and 20,000 yards of distributing mains of the B.T. system, for which no such special precautions are necessary.

I work out the cost of the latter as follows:—I use throughout bare copper mains of ·25 inch section for the distributing mains, that is to say, for the 20,000 yards at the rate given in Table 2 of £100 12s. 6d. per 100 yards, they will cost £20,125. The charging main will have to carry 910 ampères, and the extreme loss allowable being 8·25 per cent., its resistance must be 0·04 ohms. The double conductor will weigh about 45 tons; this can be laid as in Table 2, in brickwork, in cement culvert, at the rate of £306 17s. 6d. per 100 yards, or £6,137 10s. I have put down an item of £500 for the regulating gear for the A.T. system, and another one of £2,500 for the regulating gear for the B.T. system. The totals thus arrived at, and which you see before you on the wall, are £57,440 as the total cost of the A.T. system, and £59,762 for the B.T. system. These figures appear high, but I cannot see how they can be reduced, unless under very exceptional circumstances. In both cases a very large portion of the cost lies in the distributing plant, and of this, as you will gather from my Tables 1 and 2, the copper plays but an insignificant part, the real heavy charges being those inseparably connected with underground cables, viz., the cost of insulation and those connected with disturbing and replacing the surface of the streets.

Comparison of working cost and maintenance; coal bill of the A.T. system.—The generating plant on the A.T. system has to run continuously, that is to say, that the larger engines will be run for an average of three hours per day, and if it be found practically possible to sub-divide the plant into a number of engines, and work them parallel, as is the case with the direct current system, we may be able to credit the engines and dynamos with an efficiency of 75 per cent. during these hours. In order to meet the average demand of 2,100 units per day, the load diagrams show that they will vary during these hours from 400 to 720 kilowatts. We have as yet been furnished with no actual data as to the actual efficiency of the alternating transformer system at various rates of output, that is, the E.H.P. actually delivered to the lamps, divided by the E.H.P. at the terminals of the dynamos. It must be recollected that, as the transformers must be large enough to supply the maximum demand of each house, whereas the maximum demand that the station can supply is probably not more than one-third of this, the transformers during this period of three hours cannot be more than one-third loaded, and therefore it is not probable that their efficiency is more than 70 per cent. It follows that, during the hours when the plant is working at 500, 400, and 300 kilowatts, the total efficiency, that is, E.H.P. delivered at the lamps, divided by the I.H.P. in the engine cylinders, including loss in mains, will not be above 54 per cent. Supposing that the steam engines can work at 2½ lbs. of coal per I.H.P., the net quantity required per E.H.P. will be 4·65 lbs., or 6·2 lbs. per kilowatt. The output during these hours may be considered as 60 per cent. of that of the whole day, or, say, 1,260 kilowatts, therefore about 70 cwt. will be used during these three hours. During the remainder of the 21 hours the transformers will be working at a very small rate of output. It is probable that their efficiency will be reduced to 30 per cent., and the efficiency of the steam engines and dynamos to 50 per cent., or a total efficiency, that is, E.H.P. at the lamps, divided by the I.H.P. of the engines, of 15 per cent. only; therefore, during this period it seems probable that 17 lbs. of coal will be used per E.H.P. or 22·5 per kilowatt. Therefore, the coal used in producing the balance of the daily output of 840 kilowatts will be about 8 tons 8 cwt., or, making a small allowance for the lighting up of boilers, 12 tons per day. The oil, water, and petty stores may be calculated at 7s. 6d. per hour for three hours during the day, and at 1s. per hour during the remainder of the time. Therefore, the total cost of material used in running this station will be £4,849. The B.T. system, on the other hand, will show great saving on this. For the output of 2,100 units, it will be sufficient to work the generating plant for about 5 hours at approximately its greatest rate of efficiency. I have had ample experience with this class of plant, and know that we can in actual practice produce the E.H.P. at the terminals of the dynamo with the expenditure of 3½ lbs. of coal. Taking the maximum loss in the accumulators, the efficiency of the system, that is, the E.H.P. at the lamps, divided by E.H.P. at the terminals of the dynamo, will be not less than 80 per cent.; therefore, we may say that each unit at the lamps can be produced for 5·75 lbs. of coal, or 5 tons 8 cwt. per day, or allowing a 25 per cent. margin for contingencies, 2,550 tons per annum. The water and petty stores may in this case be taken at 5s. an hour for 1,400 hours; the total cost of the material for producing 2,100 units by the B.T. system will be £2,517, or only about 57 per cent. of the cost of material by the A.T. system. *Turning now to the labour in the engine room,* the table before you shows that, as in the case of the A.T. system, the hours are continuous, three shifts of men will be required, it is necessary to have two foremen, six engine drivers, and nine firemen, whereas in the B.T. system there is only one shift of men, one foreman, four drivers, and three firemen are employed. I have only estimated for two extra men in the engine room for the A.T. system, but for the B.T. system I have allowed for four accumulator foremen in charge of the four

TABLE IV.

Working Expenses and Maintenance of 10,000-*Light, or* 600-*Kilowatt, Plant.*

	A.T.		B.T.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Materials—				
Coals: 4,380 tons at 17s.	3,723 0 0		...	
„ 2,550 „ 17s.	...		2,167 0 0	
Oil, water, and petty stores: 1,500 hours at 7s. 6d. + 7,250 hours at 1s. ...	925 0 0		...	
„ „ 1,400 „ 5s. ...	...		350 0 0	
Total cost of material		4,648 0 0		2,517 0 0
Labour—				
2 foreman drivers at 45s.; 6 drivers at 30s.; 9 firemen at 24s.; sundry labour	1,388 8 0		...	
1 foreman driver at 45s; 2 drivers at 30s.; 3 firemen at 24s.; sundry labour	...		975 0 0	
Salaries—				
1 chief at £500; 2 assistants at £200 each, 4 clerks at £50 each	1,220 0 0		...	
1 chief at £500; 1 assistant at £200; 4 clerks at £80 each ...	...		1,020 0 0	
		2,608 8 0		1,995 0 0
Maintenance of Plant—				
Motive power and dynamos: 10 per cent. on £18,010 ...	1,801 0 0		...	
„ „ 10 per cent. on £13,400 ...	...		1,340 0 0	
Buildings and fittings: 5 per cent. on £11,000	550 0 0		...	
„ „ 5 per cent. on £8,000	...		400 0 0	
Transformers: 10 per cent. on £7,500	750 0 0		...	
Accumulators: 15 per cent. on £9,600	...		1,440 0 0	
Mains: 7½ per cent. on £20,430	1,532 5 0		...	
„ 2½ per cent. on £26,262	...		656 10 0	
Regulating gear: 10 per cent. on £500	50 0 0		...	
„ „ 10 per cent. on £2,500	...		250 0 0	
		4,683 5 0		4,086 10 0
		11,939 13 0		8,598 10 0
2,100 units × 365 days = 766,500 units. Cost per unit ...	...	3·75d.	...	2·7d.

accumulator stations, and two messengers. The totals thus arrived at for labour for working the systems are £1,389 8s. 8d. for the A.T. system, and £975 for the B.T. system. The salaries are £1,220 for the A.T., and £1,020 for the B.T. system. The last item we come to is one for *repair and renewals*. In both cases I have allowed at the rate of 10 per cent. on the motive power of engines and dynamos, 5 per cent. on the buildings and fittings, 10 per cent. on transformers, 15 per cent. on accumulators, 7½ per cent. on the insulated mains that have to carry 2,000 volts, 2½ per cent. only on the bare copper mains, the majority of which only have to carry 110 volts, 10 per cent. on all regulating appliances. Thus, nearly the heaviest item, the *maintenance*, comes to £4,683 5s. in the A.T. system, and £4,086 10s. for the B.T. system. The gross cost of producing 776,500 units by the A.T. system would be £11,939 13s., and the B.T. system would be £8,598 10s., or 3·75 and 2·7 per unit respectively. In order to make a fair comparison between the two plants, when worked in the most economical manner, if the generating station of the B.T. system is worked longer hours it can actually produce the daily average of 3,600 units named by the writer in *Industries* and in order to do this the sole increase in the working expenses would be in the materials, to which £1,800 would have to be added. The cost, then, of 1,314,000 units would be £10,398 10s., or 1·9 per unit, by the B.T. system.

It will be seen, therefore, that while by both systems there is a probability of a fair return on the capital expenditure, yet in almost every respect the B.T. system is a more economical one. This arises from the fact that the main cause of expense in the A.T. system depending, as it does, on continually moving machinery, is the heavy cost of material, labour, and superintendence during the long hours in which the machinery is working very lightly loaded. The B.T. system shows very favourably in this respect, as even at the latter increased output of 3,600 units per day the machinery need not work on the average more than 10 hours, so that one shift of men can do the work, and there is ample time for repair and inspection of the machinery.

DISCUSSION.

Mr. CROMPTON, having concluded the reading of his paper, said: I should add a few words to what I have read. I hope you will give me credit for having endeavoured to be absolutely fair to the two systems. My idea of being fair has been to give everything to the A.T. system that I could give it; and as I no doubt, as a contractor, may be called upon to substantiate the figures of the B.T. system, to put the prices of the B.T. system at such figures that I could get a profit on them, and that I have done. I should also say that I have preferred entirely to base my paper on the experience of my own firm. If I had chosen to back myself up by quotations in support of most of my statements from the volumes that have been written in America lately, I could have made a paper which would have lasted another hour in the reading. But you can read for yourselves, and judge whether I am isolated or not; my own view is that the current of opinion has turned very much my way. Before the discussion commences there is a personal explanation I should like to make. I have been, I may say, twitted in discussions here and otherwise that I am a recent convert to accumulators. Nothing in the world is more false. I was one of the first to discover the possibilities of accumulators. When Mr. Faure's work first became known I was one of the first to recognise its importance; I was one of the first to put accumulators into a large job—that at the Law Courts—and if I forsook them afterwards it was because the accumulators of that time did not turn out satisfactorily. It is quite possible that I used strong language then with regard to accumulators. I may say I have continued to use strong language up to quite lately, and even to the present; but accumulators have been steadily improving, and in the hands of most of the people who have had to do with them. An immense amount of thought has been spent upon them, and they are now in a condition to do this work better than any other work they may be called upon to do. Accumulators are far worse to manage in the houses of private people than in a large central station. Some of the E.P.S. cells at Vienna, which are not the least trouble, are of the older type, and were made many years ago. When I say that you will understand what I mean: the enormous number of 1,350 cells of the largest size are kept in perfect order by four or five men. I think the E.P.S. people would themselves admit that these accumulators are very far from representing what they can do now. I press upon you that accumulators can do this work of transforming, and do it, remarkably well. Just when transformers, working at their best, are at $\frac{1}{48}$th of their load, the accumulators are working at their highest efficiency—that is, during about 21 hours out of the 24.

Mr. KAPP: I think if the makers of secondary batteries had searched from one end of England to the other they could not have found a better advocate than Mr. Crompton. I do not think he advocates simply for the sake of advocating, but because he thoroughly believes in accumulators, and I can bear out one of his last remarks, for when I had the advantage of working under him it was when we planned out the Victoria Station; even then Mr. Crompton intended to use accumulators—in fact, an upper floor was to be reserved entirely for them. But they were not put in, principally because they were not reliable at that time. I am glad to hear that they are reliable now, though it is a surprise to me. Anyhow, this paper by Mr. Crompton must have a very good effect in inspiring more confidence in accumulators, and for this reason the makers of accumulators must be congratulated. I need hardly say that, although I shall in the course of my remarks have to differ from Mr. Crompton, still I admire very much the very able and plucky way in which he has fought the battle of the accumulators against transformers. He has made an impression on my mind, but he has not quite convinced me. But I am open to conviction when I see these experiments carried out with which he offers to substantiate his words. With regard to the estimates, I propose to make a remark or two on this question of maximum. Mr. Crompton mentioned that 3,600 units per head is too much for a plant which can supply a maximum of 600 kilowatts at the lamps. According to the diagram for London of course it is too much. But when you look at the others—for instance, that of Boston—I do not think it is very far out. It seems to me—of course I cannot measure or calculate it simply by my eye—but it seems to me you will find it nearly 3,600. The Cincinnati diagram, also, is not so very far out. The reason why London is smaller is that there are very few offices on, and probably in this district there are not many theatres or public halls which are going for many hours in the night. Taking the district generally, I think you will find it is rather more than 2,100. But this must be found out for every locality. I quite agree with Mr. Crompton that people generally have overlooked the fact that a conductor consists of something more than copper. The practice of simply putting on a percentage for insulation is wrong; it ought to be carefully calculated what the insulation itself will cost. But I think Mr. Crompton is going too far forward. Going through his tables, he has put down a higher cost for the finished cable and the laying than is actually the cost when you buy one. For instance, take a very high-class cable at 31s. 10d., that cable costs 13s. per yard, or for the twin main £130 per 100 yards; not as Mr. Crompton puts it, £187. The price I give is with the present price of copper. Another mistake is the addition of £8 10s. for extra copper. If a lead-covered cable can be laid straight in the ground, without going to the expense of a brick culvert, the only protection necessary is to dig your trench from 2 feet deep, roll in your cable from the drum, put in a plank, charred and tarred, so that when anybody comes to look for drains or gas he may have warning that the cable is underneath. Merely to dig the trench and put the cable in would not cost more than 3s. a yard, and with £10 for surface boxes the total comes to £155.

Mr. Crompton : Unfortunately, what I have stated is what it does cost, and what has been paid for it.

Mr. Kapp : We have therefore a difference of 25 in the two. The resistance of this lead-covered cable will be reckoned by a hundred megohms; the other by a few hundreds, or, perhaps, a thousand ohms per mile. Mr. Crompton challenges me that that is not so; but I will read what has been actually done in Milan with lead-covered cables. A cable was laid for an Edison plant. The resistance was 750 megohms per accumulator, or about 500 megohms per mile. The cable was laid two years ago, carrying 1,500 volts, and it had before laying a resistance of 1,200 to 1,500 megohms; after it was laid and had all the joints in it the insulation was still 600 megohms per accumulator, which is at the rate of about 350 megohms per mile. Another cable carrying alternating currents under 2,000 volts was laid two years ago in Milan. This was an Edison cable with two concentric conductors, one No. 4, B.W.G., and the other a four-strand No. 20 wire. This cable was laid down in June, 1885, and for several weeks was used for lighting one of the theatres. The current was then of 1,200 volts pressure. The following year the cable was used for several months in lighting the International Exhibition in the vicinity of the theatres. Careful tests failed to indicate any variation in the insulation resistance. Last December, whilst making some experiments on the coupling or multiple work, the cable was subject to abnormal conditions and broke down. It was immediately repaired, and after that the insulation resistance was found to have suffered only slight permanent diminution. The regular lighting of the theatre was entered upon a few days later, and it has been in continual operation since without the slightest hitch. I will give you another instance of the comparative cost of cables. A Berthoud-Borel cable of 150 square millimetres, which is a little smaller than 19/10, allowing for the increased price of copper, cost £40 per 100 yards.

Mr. Crompton : That is a great deal higher than my price.

Mr. Kapp : The question is whether it is worth while to save 5 per cent. in the one and 14 per cent. in the other. If there is no leakage or short-circuiting it may be worth while. I would not be the engineer responsible for keeping up the insulation of underground conductors put underground. Mr. Crompton said we should use in the alternate current plan what he calls the charging main at the same time, the network going through the whole district. That is not a good plan, for in this way you would have 22,000 yards of high-tension cable. I advocate the plan of having a long line of mains and the network of low potential cable, and only a few high tension feeders going to stated points. By this means you would only have 4,000 or 5,000 yards of high tension, all the rest being of low tension. You would then have efficiency. In this network are installed a certain number of transformers, 10 or 12; but I am coming to that presently. As regards the size of distributing mains, Mr. Crompton takes two mains of ¼ square inch section, and feeds these from four local batteries which have been installed in mews as near as they were to be got to the line of lighting. But I think that either he has too few batteries, or he has too small a section of cable. It is evident that the fewer the points at which we feed our network of mains the larger must be the section of this network to be able to take the currents without serious loss of potential. Mr. Crompton mentions 4 volts as the maximum variation liable. Well, I think that is rather too much. You must remember, if you allow 4 volts difference of pressure it means something like 10 to 15 per cent. difference in light. I doubt whether the British householder would put up with the variation in the lighting with the electric light that he does with gas. You ought to take two, or, at the outside, three volts variation in 100. You must allow for possible error at least 1 volt, so that if you start with 4 volts loss in your mains you will have a total variation of 5 volts, which is objectionable. It is a very difficult matter to say what size of main is required with a given amount of current in a district. It depends to a great extent on the configuration of a district, because you would connect the network in as many points as possible, so as to take advantage of the carrying capacity of the cable through cross streets. Therefore it is impossible to say off-hand whether a ¼-inch main is enough for a 600 ampère current or not; but we can test this by reference to an installation actually established, and for this purpose we may take an installation which is in everybody's mind at present, that at Bradford. Many of you have no doubt seen the forms of tender and specifications for this lighting; and by a map of Bradford may easily verify what I am going to tell you. At Bradford there are three feeding centres. There will be about 3,000 lamps installed, and the whole of the current will have to be supplied to these lamps through three feeding centres, making 1,000 lamps depending on each. The main which is to be used there is a 19/12, which is ·177 square inch in area The variation permitted is either 2 or 3 volts, within the limits I have just mentioned as being admissible. With a main of ¼ square inch it would be possible at Bradford to supply 1,400 lamps from each feeding centre, or altogether 4,200 from the three. With mains such as Mr. Crompton proposes to use, to supply 10,000 lamps simultaneously burning you would require nine or ten feeding centres. I must here say we cannot take advantage with Mr. Crompton's system—which is really a five-wire system—of the interlacing network, as we can in the simple two conductor circuit, because he works with four distinct potentials, and you can only interlace parts of the same potential. So that we should require with this system of batteries rather more feeding centres, because we do not get the advantage of interlacing links in the network, and must therefore have ten and not four in order that the conductors may give a variation not exceeding 2 or 3 volts. It is therefore necessary to have ten attendants and not merely four, for your local batteries, which makes an extra £600 for working cost. But there is another way out of the difficulty. We can adhere to our six centres, and make the mains large enough to carry the additional current without a drop of 2 volts. That is to say, instead of a main of ¼ square inch, we should have to use a main of 1½ square inches. This main, according to Mr. Crompton, would cost about £200 per 100 yards. That is exactly twice what Mr. Crompton has in his estimate, so that the estimate would have to be increased by £20,000. Then the maintenance would have also to be increased by £1,532; that is the interest on the mains, and it would probably be much cheaper to sub-divide the batteries and have more attendants. I should also like to ask Mr. Crompton whether he has included in his estimate an item for rent of rooms where the accumulators are to be. He speaks of the difficulty, almost impossibility, of getting a quarter-inch pipe on to a man's premises, yet he wants to get a whole set of batteries on. This makes another £500 a year which is not in the estimate. Then adding the pay of the men who look after these things, that brings it up to about £1,100 which has to be added to the working cost. This item alone puts a very different complexion on the two systems. Supposing we adopt Mr. Crompton's quarter-inch main and feed, this by alternating transformers. We could do with ten transformers each capable of supplying a maximum of 1,000 or 1,200 as a shunt; it will not be necessary that the total capacity of the transformers should be larger than the total capacity of the station, because they feed a common network, and if in one portion of the network the demand is small, it may be large in another portion. There is a certain power of equalisation in all this, so that you do not want more than 10 to the 1,000 with the transformers to do the work. Mr. Crompton says he is ready to supply batteries at the figures he has given. I know many people who would be perfectly willing to supply transformers at the following figures, viz., £3,000 for ten transformers, each giving a thousand lights. Thus, then, there is a reduction in the estimate of £4,500; Mr. Crompton has put it at £7,500. Then the space occupied by the transformer would not exceed, roughly speaking, about 20 cubic feet. It is not very difficult to find accommodation for 20 cubic feet, even if you have to dig a hole in the ground 5 feet square and deep, and lined it with a cast iron box. If you can put whole batteries with the fumes of sulphuric acid about them in mews, it cannot be difficult to find a little cupboard somewhere in the mews where you can put your transformer. Of course, you understand that when I speak of a cupboard I mean one which you can lock and which has an iron door. If the author has over-estimated the cost of transformers, I am rather inclined to think he has under-estimated the cost of the batteries. I hope he will not think that I disregard what he tells us he is willing to do; but I should be sorry if he had to do it at a loss. My authority for supposing that he has under-estimated batteries is Mr. Crompton himself. A few months ago I asked him, as a question of scientific interest more than anything else, what in his opinion should be the cost to be allowed for batteries which should have a very rapid discharge, and from the figures he was kind enough to supply me with I have formed my present opinion. Taking an average, and putting the most favourable construction upon the figures, he found that the cost would be £30 per kilowatt. Well, I should be glad to know exactly whether I understand his paper aright, for according to his paper, the cost per kilowatt is only £16. He allows £9,000 for batteries, from which he expects to get 600 or 650 kilowatts. That comes to £15 or £16 per kilowatt. Now, if £30 is right, the batteries should cost not £9,000, but £18,000. I should be glad if Mr. Crompton would tell us in his reply whether I am right in interpreting his figures to mean that he knows somebody who will supply batteries costing, say £160, to give 10 kilowatts output. I should now like to say a word about the efficiency of alternating transformers. Mr. Crompton says that they will give 70 per cent. efficiency when loaded to one-third, and when loaded lowest will give less than 30 per cent. Some of you were no doubt here when Prof. Ayrton gave the result of his experiments with a two horse-power transformer, which, when working at 318 watts, that is at 21 per cent., a fifth of its full output, gave 80 per cent. efficiency. At a third of the full output the efficiency was 85·8 per cent. I maintain that it is not necessary to work a transformer to its full capacity. Take one-half, or at the outside one-third of the output. If you adopt the plan of working a common network, using about a dozen transformers, when the demand is full turn off one or two transformers, and let the rest do the work. If the supply falls to one-tenth, turn off ten transformers, and leave one or two to do the work. The efficiency of the transformer does decrease when the load decreases, but the efficiency of the feeding mains increases, if you allow 20 per cent. less in your feeding mains, which would be a very economical way of working. At the maximum output let the main absorb 20 per cent. of power, then you have this 20 per cent. to draw upon when there is a smaller output. So there is a tendency toward the loss in the one apparatus being balanced by the gain in the other, and if you work the transformers with a reasonably large output you will find the efficiency does not vary very much; there will be a little difference, but not so great as Mr. Crompton makes out. I should like to conclude my remarks by asking Mr. Crompton a question. I do not put it forward as an invidious criticism, but merely as a matter of interest. I am very curious to know how it is done—that is, the regulation of his system, which is a five-wire system, with the accumulators placed parallel to the lamps. When we work batteries in private installations we use 2½ volts for the charging current, and when the batteries work the lamps we reckon that they get 2 volts out, so that the E.M.F. of the batteries must be 20 per cent. greater than when they are discharged. Now, how is this done? How can Mr. Crompton ensure constancy of potential when he is charging or discharging? I can only see two ways—either by using rheostats, as Edison has done, or by shifting the terminal on the battery, so that instead of having 52 cells at one time you may have only 48 per cent., and when heavy charging is on, only 47. But now comes the difficulty, which I should like some battery maker to explain. These end cells receive different amounts of charge from what the other cells of the battery receive. Out of 50 there may be 45 which get charged and discharged evenly; but the end cells will get charged irregularly, and I would like to know how this affects the cells

(*To be continued.*)

Physical Society, April 14th, 1888.

"The Variation of the Coefficients of Induction," by W. E. SUMPNER, B.Sc. (*Abstract of Paper.*)

The coefficient of self-induction of a coil whose magnetic circuit is wholly or partially composed of iron is such a variable quantity that it is necessary to define its meaning more exactly than has hitherto been done.

Of the many definitions possible to give, the best is probably that according to which it is the ratio of the induced electromotive force to the rate at which the current is changing. Since the induced electromotive force is equal to the rate at which the magnetism is changing, the ratio in question is the rate at which magnetism changes with the current. From this it follows that if a curve be drawn whose abscissæ represent the current and whose ordinates represent the amount of magnetism or the number of lines of force enclosed by the coil, the coefficient for any particular current will be represented by the rate of slope of this curve. The shape of these curves is well known from the researches of Prof. Ewing, Dr. Hopkinson, and others. They are generally such that as the current increases, the curve slopes very gradually at first but becomes steeper and steeper until the current begins to saturate the iron. The curve then bends over and the slope becomes ultimately small. When the current is diminished, the curve of magnetism, owing to magnetic hysteresis, does not return on itself but is such that it becomes steeper and steeper as the current is diminished.

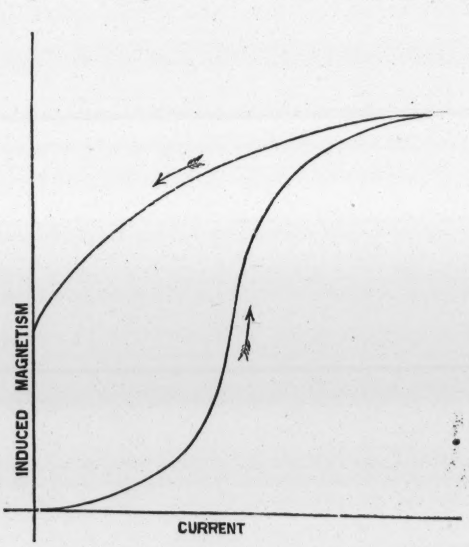


FIG. 1.

Fig. 1 shows the general shape of the curve connecting the induced magnetism with the current. The arrows indicate the way in which the current is changing. Fig. 2 is a curve drawn from fig. 1., and is such that the ordinate for any particular current represents the rate of slope of the curve in fig. 1 for the same value of the current. The coefficient of self-induction for increasing currents at first increases and then diminishes, while for decreasing currents it is small at first and steadily increases as the current is brought to zero.

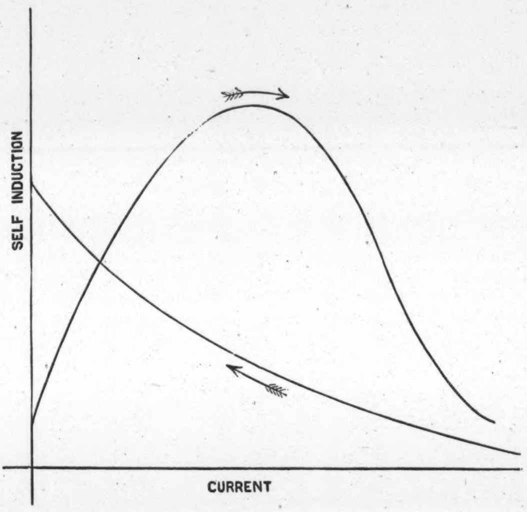


FIG. 2.

Many experiments made on an electro-magnet on the field magnets of dynamos and on a Kapp transformer have completely confirmed these conclusions. Owing to magnetic hysteresis the nnmber of lines of force enclosed by the coil will depend not only upon the current flowing at the moment, but also on those that have been flowing previously.

The value of the coefficients will for the same reason depend on the former magnetising forces, and may be obtained of almost any value by using suitable magnetising currents before determining its amount.

The coefficient for an increase of current will always be different from that for a decrease of current. These effects of hysteresis were obtained in all experiments made, and were very marked in the case of a Kapp transformer. Several methods were used for determining the coefficients. The chief were Maxwell's absolute method, and a modification of it by Prof. Ayrton, a comparative method (due to the author) by which the coefficient was found in terms of the capacity of a standard condenser and the secohmmeter of Profs. Ayrton and Perry.

There is a simple graphical method for determining the current flowing at any moment when the electromotive force is given at each instant, and the coefficient of self-induction is given for every value of the current. In the case of a simple circuit the following equation holds true:

$$\mathrm{E} - \mathrm{L}\,\frac{d\,c}{d\,t} = \mathrm{R}\,\mathrm{C}.$$

Where C is the current, E the electromotive force (which is not necessarily constant), L the coefficient of self-induction, and t the time, it follows that

$$\frac{d\,c}{d\,t} = \frac{\frac{\mathrm{E}}{\mathrm{R}} - c}{\frac{\mathrm{L}}{\mathrm{R}}} = \frac{\mathrm{C}_0 - \mathrm{C}}{\mathrm{L}/\mathrm{R}}.$$

Now, $\frac{\mathrm{E}}{\mathrm{R}}$ is what the current would be if there were no self-induction, and is given, we suppose, for every moment. Call it C_0 and plot a curve having C_0 for ordinates and time for abscissæ. Plot another curve having current for ordinates and the corresponding valve of $\frac{\mathrm{L}}{\mathrm{R}}$ as abscissæ. If L is given in secohms and R in ohms, L/R will be in seconds, and must be plotted to the same scale as for the former curve. It will be found best to plot the values of L/R in the negative direction as indicated in fig. 3. The construction is then as follows:—Suppose P_1 be the given initial point on the current curve. Project it horizontally and vertically to the points T_1 and Q_1 on the curves for L/R and C_0;

project the point Q_1 horizontally to R_1 on the current line, draw from P_1 a line parallel to the line $T_1 R_1$, and choose a point P_2 on it not far from P_1. The point P_2 may be considered as the next point on the current curve, and the process which is indicated in fig. 3 may be repeated for the point P_2 to get a third point P_3 and so on, until the whole curve connecting current and time is obtained. The curves are very easily obtained if squared paper is used and have been drawn for several cases of steady and alternating currents, and have yielded some interesting results. If the coefficient, L, is a variable the time taken to establish a given portion of a steady current will vary with the amount of the current to be established. The current may increase at very different rates during the rise, and may hasten and slow and hasten again while increasing in a very remarkable manner.

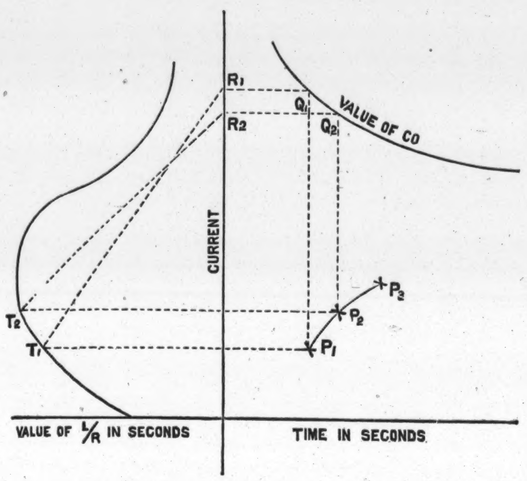


FIG. 3.

Prof. Thompson had observed some of these effects experimentally. The general effect of the variation of L is to introduce ripples into the curve of current obtained by assuming that L is constant and equal to the mean of the different values. It is generally assumed in calculations connected with alternating currents that the E.M.F. of the dynamo is a sine function of the time, and that the coefficient, L, is a constant quantity. Although these assumptions are well known to be inaccurate, they are generally believed to be sufficiently true for practical purposes. It is very doubtful whether this is the case. Experiments made on the Ferranti dynamo at the Central Institution have shown that the electromotive force curve is such that its ordinates differ from those of the most favourably drawn sine curve by as much as ± 5 per cent. With other dynamos probably much greater variations occur. Probably, also, with some dynamos the curve of electromotive force is more like that which would result from the sum of two sine curves, one with a period corresponding with the current alternations, and the other with a period coinciding with that of the dynamo revolutions. This will occur whenever there is want of symmetry in the machine, and this effect will be much magnified in the current curve if the self-induction is large and the alternations very rapid. That alternating currents are not generally simple sine waves seems to be indicated by the well-known pulsations to which electric lights fed with alternating currents are subject. These pulsations are too slow to be due to the ordinary current alternations, but might be in time with the revolutions of the dynamo. They are so marked in the case of one important London installation, that Mr. H. B. Bourne has observed that a rapidly moving object does not present a continuous blurred appearance as if under the action of a steady light, but discontinuous images, so that in fact if a walking stick be swayed rapidly to and fro the appearance is as if there were five or six instead of one only. It does not appear to have been noticed that self-induction, although always delaying the rise or fall of currents, may sometimes hasten the discharge of a condenser. The current which discharges a condenser has both to rise and fall. The self-inductor will never delay the rise so much as it delays the fall, because in the former case the potential difference of the condenser is high, while in the latter it is low. If the self-induction in the discharge circuit be not too large the condenser will discharge quicker than if no self-induction were present, and it will always be possible to halve the time of discharge in this way. As a lightning discharge is essentially the same as that of a condenser, it seems probable that a lightning conductor will be only improved by the insertion of self-induction. Dr. Lodge has recently shown that an iron conductor is preferable to a copper one, and has accounted for it by supposing that the iron conductor has less self-induction than the copper one. It is impossible at present to say whether this is so or not, but the effect may be due to a quite opposite cause.

CORRESPONDENCE.

Electrical Traction.

——— " Sibi quivis
Speret idem, sudet multum, frustraque laboret,
Ausus idem."—HORACE.

Your correspondent, " C. E.," with, no doubt, a laudable desire to promote the advance of electrical traction in this country, has published his ideas on the subject in the columns of your journal and also in those of a contemporary. I think, therefore, he is willing to sacrifice *pro bono publico*, whatever degree of merit is claimed for his "invention," either as regards originality or utility.

But the unfortunate part of the argument consists in the fact that Mr. A. J. Jarman has already covered the ground in this direction by his prior patents, as you pointed out in the foot note in your last issue. To my mind, the scheme of employing a movable field magnet arranged to slide over either of the two armatures which are mounted upon the same spindle, would constitute a distinct infringement of Mr. Jarman's patent rights. In order to ensure the sliding field magnet passing freely from one armature to another, taking into consideration the small amount of clearance between the armatures and the poles provided in a well-constructed motor, perfectly rigid guide bars would have to be fixed to the motor carriage under the tramcar, therefore the weight of the second field magnet (as used on the Jarman car at the present time) is nearly compensated by the guide bars and the necessary gear for sliding the field magnet. And, taking into consideration the fact that said guide bars would have to be planed, and a cross slide fitted therein to carry the field magnet, to say nothing of the risk of stripping an armature now and then, I do not think that the idea possesses the advantage of economy over the original invention.

The method of carrying the storage cells upon a truck is certainly unique, and I believe it is quite original. Imagine an electrical tramcar ascending a gradient of, say 1 in 30, with two or three passengers only, and preceded or followed by the truck before mentioned! I wonder how "C. E." provides the necessary adhesion in such cases? Should his ideas ever take a tangible form, he will find that this appendage to his electrical car will be highly appreciated by the juvenile population of our metropolitan suburbs, unless, indeed, he provides an induction coil and suitable contacts all round the truck.

I have been for some few years past interested in the subject of electrical traction, and have, in a humble way, had a little to do with its practical development, and therefore I should not like, however indirectly, to discourage anyone who is zealous in promoting its progress; but in this case I cannot help thinking that there is more meaning in your correspondent's letter than is apparent upon the face of it. Any improvement upon an existing invention is, of course, admissible, but when the advantage of the improvement is doubtful, and the *tout ensemble* merely suggests a method of utilising such invention without paying the inventor the compliment of asking his leave, the proceeding is prejudicial to the cause of scientific progress. But I have no doubt that Mr. Jarman is on the alert.

Fredk. Walker.

April 16th, 1888.

An Electro-Motor for Tramcars.

I notice in the last issue of the ELECTRICAL REVIEW a description of an electro-motor under the above heading. I hope you will allow me space to call attention to the fact that an electro-motor constructed upon the lines laid down by "C. E." would be a direct infringement of my patent, dated February 26th, 1886, No. 2783. It may be possible that "C. E." was not aware that the employment of two armatures upon one axle for the purposes specified is an infringement of the above patent. I must here state that if "C. E.," or anyone else, employs such a motor as he describes for the propulsion of tramcars he will be liable to an action for infringement. I regard the motor as described by "C. E." a direct piracy of the above patent. The motor of my design has a considerable advantage over that described by "C. E.": it enables the propelling power to be doubled any time it is required, which is an essential item in enabling the car to keep time, no matter the number of stoppages.

Respecting a truck of storage cells running behind a car, this may answer admirably for a toy; for many reasons it can never answer in actual working of a large car. It is doubtful whether the Board of Trade would ever sanction the adoption of such a scheme. If storage batteries are to be employed, their place is within the car, if for no other purpose than giving weight upon the driving wheels. The employment of two armatures in my form of electro-motor has proved itself of considerable advantage in ascending inclines, a point of superiority that "C. E.'s" design can never possess.

A. J. Jarman.

Brixton, S.W., *April 17th*, 1888.

Magnetic Resistance.

Referring to Mr. Housman's letter in your issue of the 6th, of course if "magnetic resistance" could be of assistance in giving clear ideas, I should never dream of objecting to it. The chief objection, or one of the chief objections, seems to me that the term would obscure people's ideas. It is in the interests of the weaker brethren, among whom of course no one would class Mr. Housman, that I object to the term magnetic resistance.

If a sort of irregular ring surface, at every point parallel to the lines of current, were taken in my coiling magnet illustration, of course the resistance would be definite; but it is not definite unless this surface is defined. The whole of the space surrounding the coiling magnet cannot be taken, because the current flows through the magnet itself. Similarly in a dynamo lines of induction may be considered to cut the copper of the magnet coils, so that no definite "magnetic circuit" can be taken.

If, to take Mr. Housman's illustration, air were to become conducting, I would not say resistance was a vague and misleading term; but I would say that you could not talk of the resistance of, say a horseshoe, as a definite quantity when in conducting air.

I am afraid I have not made myself very clear as to the question of dimensions. I pointed out that "magnetic conductivity" is analogous to inductive capacity, and that the dimensions are the same if one is measured in the electro-magnetic system, and the other in the electrostatic system. Mr. Housman seems to think I mean they are the same thing. The "dimensions" do not depend only on the nature of the quantity, but on the units chosen.

As to "magnetising force," I do not know what Mr. Bosanquet may mean by the term, and have not his papers at hand, but can hardly think that he uses it in any other than the usual sense. As to electromotive force, I pointed out the confusion in terms here to show that the introduction of "magnetic resistance" would make matters worse. Electromotive force is universally used for difference of potential, but it is also used by Maxwell for rate of decrease of potential, or more strictly, for a force which varies as the rate of decrease of potential. Mathematical writers use "magnetic force" or magnetising force to denote a force which may be measured by, or varies as the rate of decrease of magnetic potential. If "magnetomotive force" is now introduced as the line integral of this, we will soon have endless confusion between magnetising force and magnetomotive force.

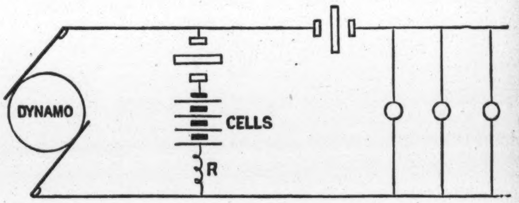
Your correspondent asks how the magnetising force in iron is to be found without the notion of magnetic resistance. I can only say I should never think of involving resistance in the problem, any more than I would in the case of a charged conductor and a dielectric.

As to magnetic hysteresis, or persistent magnetism, I think Prof. Ewing's argument against the term magnetic resistance is strongest of all. The contemplation of a negative resistance, which produces a current when there is no electromotive force, is really too terrible. A state of strain remaining after the stress is removed is quite another thing.

Jas. Swinburne.

Accumulator Charging.

Perhaps some of your readers may be able to account for the following strange circumstances in accumulator charging. I am running 55 volt lamps off a compound dynamo and accumulators. Every night I switch on the dynamo to the cells and regulate the current through them by a variable resistance, R, if the volts differ much from those of the dynamo. Then I switch on the lights and run all night. On attempting to do this as usual last week, I found I had an enormous current in the accumulator circuit, as if from a short circuit. I cut out the cells and ran without them that night. Next day I examined the connections from dynamo to cells and found all right, though the same difficulty existed when I attempted to charge. I then inserted an incandescent lamp in the place of the variable resistance, and found it burnt brightly, and on taking the terminal potential I found it was 90 volts. The machine was running at 50, so I knew the dynamo volts were acting with the accumulator volts and not opposing. No alteration had been made in the connections, and dynamo + pole was connected to accumulator + pole. For three days I was unable to see to this, but on again attempting to charge last night I found all was right, and the volts of the accumulator opposed those of the dynamo as usual. No alteration whatever had been made in any of the switches or connections, which are permanent.



A Puzzled Electrician.

April 17th, 1888.

Telephone Infringements.

Referring to the letters of Mr. John Sawrey and Mr. J. S. Ross in your last issue, with all due courtesy to these gentlemen, I cannot allow myself to be drawn into a discussion on matters which are at present *sub judice*.

I can only state that Mr. Sawrey is quite incorrect in his description of the construction of the telephone receivers of the Equitable Telephone Association that have been attacked by the United Telephone Company, and is entirely in error as regards his view of the scope of the latter company's contentions, which, as is shown by documents at present in my possession, are much wider than apparently either he or Mr. J. S. Ross find it convenient to assume.

A. A. Campbell Swinton.

75, Queen Victoria Street, E.C., *April 16th*, 1888.

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